Southern Opportunities Number

Metallurgical & Chemical Engineering

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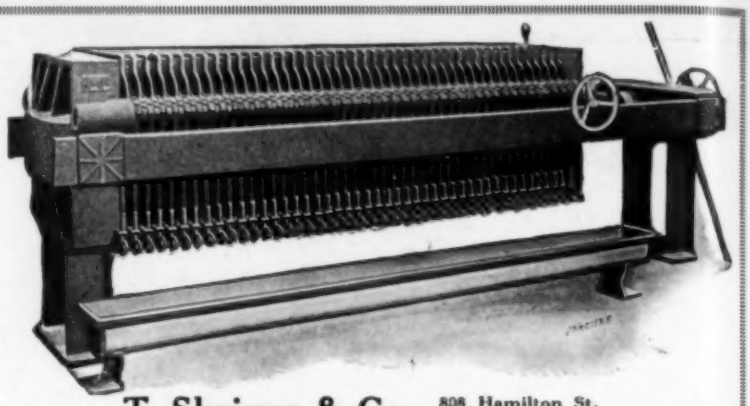

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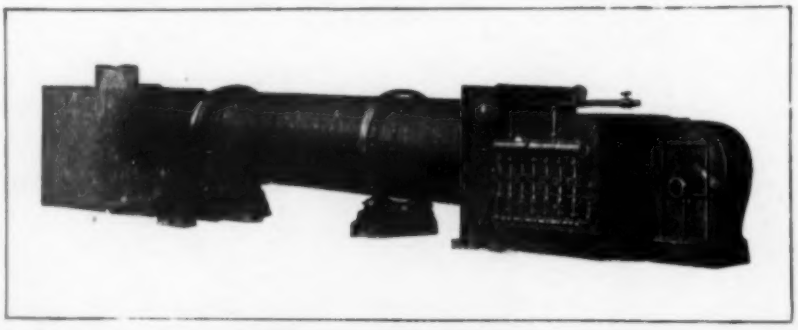

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The American Electrochemical Society and the South

THOSE who were fortunate enough to attend the National Exposition of Chemical Industries in New York last fall must have been struck with the exhibits made by Southern cities, railroads and industrial organizations. The impression was gained that not only was the South coming to the front, but that it had much to offer in substantiation of its claims for recognition. The material resources of the region were strikingly displayed, and there was tangible evidence that the South possessed and could produce a number of minerals that were much needed in this country, especially after the war disturbed foreign commerce.

We are inclined to suspect that those exhibits were real factors in the decision of the directors of the American Electrochemical Society to hold the next meeting in the South. Former invitations had not been lacking from this hospitable region, but always there seemed more pressing reasons for meeting elsewhere. This year, however, there could be no more appropriate combination, and since the decision was reached, the conviction has grown that no mistake was made.

The exigencies of war are bringing to fruition some of the cherished plans which Southern scientists and engineers have been trying for years to bring to the serious attention of the country. Confident that their region was destined to play a large part in national industry as well as in agriculture, and knowing the resources of mineral wealth and water power with which the South is favored, they were, nevertheless, unable until recently to impress the nation with the vital facts. Happily the deferred recognition is now at hand and those who have labored are to secure their reward.

No body of scientists and engineers is better able to appreciate the South's potentialities than is the membership of the American Electrochemical Society. Skilled in applying the electric current to metallic and non-metallic minerals, these gentlemen view broadly the fields of electrochemistry and electrometallurgy. They are interested in raw materials and electric energy, and since hydroelectric power offers certain marked advantages for their processes, they have a double interest in a territory that offers the combination of mineral wealth and water power. The South may well feel that in receiving this body of men and displaying to them her wealth, she is making valuable friends as well as entertaining appreciative visitors.

We have been glad to make an effort to serve both the Society and the South by presenting in this issue a summary of Southern resources contributory to electrochemistry and metallurgy. For the numerous contributions that make up the whole story, we are under

obligation to many busy men who responded to our request for coöperation. We believe the result justifies their efforts. We have here the background for a story that will be written in the future, a romance of industry in which will be woven the mineral resources, water power and engineering talent of a hospitable and chivalrous people.

Expanding Program of Nitrogen Fixation

IT HAS frequently been remarked during the course of the war that the United States is slow to get started, but once under way she will acquire a terrific momentum that will carry her through to a successful finish. The nitrate program is a case in point. For years a few knowing persons have preached nitrogen fixation in season and out, recognizing its importance to the nation in times of peace, to say nothing of its essential nature in war. But the words have fallen on deaf, or at least unappreciative, ears. Even within the period of the war there has been a failure to realize how largely we should go into nitrogen fixation, and our apparent needs now exceed by several times the most radical predictions of a few years ago.

The full program thus far announced is as follows: Plant No. 1, using the General Chemical Company's ammonia process, was built and will be operated by the Government at Sheffield, Ala. Plant No. 2, using the cyanamid process, is to be built and operated for the Government by the Air Nitrates Corporation, at Muscle Shoals on the Tennessee River, near Sheffield. Plant No. 3, according to a recent announcement credited to the War Department, is to comprise two units, located at Toledo and Elizabethtown, O. It is understood that Plant No. 4 also is to be built in the near future but the location is not yet decided upon. The two units of Plant No. 3 will have a combined capacity equal to that of Plant No. 2.

Although the location of the plants near Muscle Shoals on the Tennessee River was undoubtedly determined by the proposed hydroelectric developments there, it will be necessary to erect steam-electric plants for immediate use. Plant No. 1 will be served by the Alabama Power Co., which is now erecting a steam plant of twelve 1200-hp. Stirling boilers. Plant No. 2 will have twelve 1500-hp. boilers and two turbo-generators, one of 60,000 and the other of 7500 kw.

Truly we have been slow to get under way, but once started we are undertaking things largely. Some day the whole story will be written and it will make interesting reading.

Light in the Offing

THE appointment of John D. Ryan, president of the Anaconda Copper Co., as director of the aircraft program will be hailed with satisfaction and delight by the engineering fraternity of the country. Signs are multiplying that the Administration is profiting by the criticism of former appointments and is taking heed of sound advice and counsel. Following closely upon the announcement of the appointment of Charles M. Schwab to direct our shipping program, and Edward R. Stettinius in charge of purchasing for the War Department, the reorganization relating to aircraft production brings additional light and reassurance. Stettinius, Schwab and Ryan are synonomous with achievement and accomplishment, and are the type of men who have done things in a large way in business. We need more of their class in the conduct of the war, and it is to be hoped their number will increase. If the proposal to establish a minerals administration is carried out, it will be necessary to find a capable man to direct the work, and another opportunity will be given to make a wise selection. Some time ago when a Congressional committee reported on its investigation of delay in aircraft construction, it criticized the Administration for a policy of holding aloof from men who had special knowledge of certain branches of industry. The criticism was sound. Whether there has been distrust and suspicion of so-called big business, we do not know, but there is no doubt that we have lost immeasurably in time and production by failing to take advantage of that peculiar ability that has created and directed our largest industrial enterprises. No other nation has conceived and executed industry on such a huge scale. We have talent in abundance and variety, and of unquestioned patriotism. In our judgment it is the duty of the Administration to avail itself of such ability.

The Trend Toward Electric Brass Melting

READERS of this journal a decade and a half ago will recall that the rôle of the electric furnace in iron and steel metallurgy was then regarded as one of the most fascinating problems. Much speculation was indulged in regarding the future, but it was considered a safe prediction that the manufacture of special steels would be the line along which the electric furnace would make a successful bid for recognition. How complete that recognition has been is a matter of several years' record, for not steel alone, but pig iron as well has flowed from the electric furnace.

More recently the onward march of metallurgy has taken the electric furnace into the domain of brass melting, and the conquest bids fair to be complete. The main reasons underlying the economic change now taking place from fuel-fired to electric brass furnaces are to be found in the conservation of time, metal and fuel, improvement in the sanitary conditions of the foundry, and excellence in the strength and uniformity of alloys. The metallic loss, especially of zinc, is said to be lessened by at least one-half. With a thermal efficiency averaging perhaps seven times that of a fuel-fired furnace, the electric furnace affords a great saving even when using current from a steam-electric plant. With hydroelectric current the saving is infinitely greater. The saving of time and labor per unit of production is of material moment, especially under present industrial conditions.

There are on the market today over a dozen different electric furnaces for non-ferrous metallurgy, representing five different types, viz., induction, radiating-arc, direct-arc, resistance, and high-frequency. These are used for the production of a variety of metallic alloys which may be classified substantially as follows: (a) yellow brass with less than 3 per cent lead; (b) red brass and bearing-metal irrespective of the lead content; (c) red brass with low lead content; and (d) the aluminium mixtures.

The induction furnace is the type hitherto found most suitable for melting yellow brass with a spelter loss of one per cent or less. This is due to that characteristic of the induction furnace which permits accurate heat control, with consequent uniform temperature throughout the bath of metal. The advantage is obvious if it is desired to keep the volatilization of zinc at a minimum. Just recently the U. S. Bureau of Mines has perfected a new radiating-arc furnace which is said to be particularly suited to brass melting.

Class (b) alloys mentioned above are best melted in a furnace having a plain solid bottom devoid of all complications so that any lead which finally gets into the refractory hearth can do no harm even though it breaks through. The radiating-arc or the high-frequency furnace suggest themselves here and the former is thus much used and to some extent also the direct-arc furnace. The high-frequency furnace has not yet made its commercial appearance although it should fit in well in the non-ferrous industry, provided the cost can be brought reasonably low. Class (c) alloys give the least trouble, with comparatively low zinc content and little lead. The induction furnace lends itself to the production of red brass with low lead, less than three per cent; otherwise experience has shown that the lead may at any time percolate through the lining and damage the transformer coil. Class (d) alloys or high aluminium mixtures are formed readily with low loss in the resistance and radiating-arc furnaces. As far as known, these furnaces only are employed in this way commercially. High-nickel alloys are melted by all of the furnace types mentioned, and the best has yet to be determined. In general that furnace is being employed which gives not only the best metallurgical results, but which has also the simplest construction. Unfortunately these two features are not always coincident, as evidenced by the induction furnace which gives splendid results with yellow brass, yet its construction can hardly be called simple. Outside of the bottom-electrode type of furnace, all of the other electric furnaces which have reached the commercial stage are of fairly simple design and rugged construction.

Broadly speaking, the trend toward the electric furnace in the manufacture of brass and other alloys was heightened by the very poor sanitary conditions prevailing in many foundries where coke or oil furnaces polluted the air which the operators had to breathe. As the air remains clean with a properly chosen electric furnace, this characteristic alone was sufficient warrant for the investigation of electric melting devices. Other advantages have been found with later experience. The saving in labor is marked and the ability to keep experienced workers is pronounced. It is possible to keep better and more accurate records, have better technical supervision, turn out larger heats free from oxidizing influences, with almost absolute heat control and a very high thermal efficiency, approaching 80 per cent. All of these things observed in practice have so far induced the producer of non-ferrous alloys to install in the United States alone over 50 electric furnaces of different types, all of which are now operating and giving satisfaction to their owners. Plainly the trend is toward electric melting and the superiority of the electric furnace seems to be an accepted fact.

Will Dollar Silver Increase Production?

SEVERAL years ago it seemed that an enhanced price for silver was inevitable, since the rapidly expanding volume of the world's business was accompanied by only a moderate increase in the production of the precious metals, the shipment of gold and silver, of course, being the manner by which international credit balances could be leveled. The use of silver as a medium of international exchange received a powerful stimulus when Great Britain and the United States under war exigency embargoed the export of gold for this purpose except to certain governments. Enormously increased quantities of silver have therefore been exported from America to the Orient during 1917; China receiving twelve million dollars worth, double the quantity of 1916, and India absorbing $24,400,000, an increase of twenty-two millions. Add to this the quantities of metal coined to pay Allied troops, and the increasing amounts used in the arts, all producing an undoubted shortage of spot silver, which caused a continued rise in the price, rapidly culminating at $1.085 on Sept. 21, 1917. Cancellation of many orders on this runaway market caused a sharp recession, but the underlying demand must ultimately reappear. At the present time silver cannot be exported except under license; therefore there is no open market, and the price is held down by the lack of governmental purchases.

That Congress can act expeditiously when it so desires is shown by the fact that Senator Pittman's bill "to conserve the gold supply of the United States; to permit the settlement in silver of trade balances adverse to the United States; to provide silver for subsidiary coinage and for commercial use; to assist foreign governments at war with the enemies of the United States; and for the above purposes to stabilize the price and encourage the production of silver," was passed by both houses in short order. Debate in the Senate brought out the fact that the proposal "to assist foreign governments at war with the enemies of the United States" was the biggest factor in the whole plan, resulting from a demand by India against "the most important ally of the United States," Great Britain. Of the 350,000,000 silver dollars which are to be melted for export, Senator Owen admitted that the United States needed 50,000,000 "to take care of our jute from India alone."

The *modus operandi* of the bill as passed is as follows: The Treasury will remelt from its stock of nearly 500,000,000 ounces, 350,000,000 silver dollars, withdrawing the corresponding silver certificates from circulation and replacing them by an issue of Federal Reserve banknotes secured by United States gold notes. The mint will then proceed to re-stock the vaults by purchase of all available silver as fast as it is produced at $1.00 per ounce, again replacing banknotes by silver certificates.

Stabilization of conditions in Mexico would do much toward relieving the existing silver shortage, since in normal times she produced considerably more silver than the entire United States. However, this is apparently too much to ask; there is even little assurance that the estimated annual production of about thirty million ounces will materialize.

It is even doubtful that dollar silver will largely in-

crease the United States production beyond the present rate, which has been approximately stationary at seventy-four million ounces for the last three years despite the large increase in the market price. This idea is reinforced by a brief consideration of our present supply. About one-quarter of it comes from the refining of blister copper, which has enjoyed a fair price during 1917. As a consequence no sudden expansion in production of the red metal is to be expected. Another twenty-five per cent of the silver produced in the United States comes from the gold and silver mills. Here the full effect of the added price will undoubtedly be felt immediately in stimulating the output of the cyanide districts of Nevada and elsewhere.

The remaining production (practically half of the whole yearly output) comes from lead and lead-zinc ores. In this most important division, expansion of silver production will be much hampered by the divergent interests of the miner and smelterman. A large price for silver will tend to stimulate silver mining, but the lead smelters will continue to decline large increases in ore shipments. The smelter schedules are usually written so that the charge for treatment is assessed by paying the miner about four cents for the recoverable lead. If the lead market is high, the smelter profits. If the lead market is low, as at present, the largely increasing cost of labor, coke and usual repairs wipes out any balance on the smelter's books. Consequently, until lead prices advance in the face of increasing production, or ore contracts are rationalized, no great incentive for the smelters to increase their output of base bullion is apparent.

Iron and Steel in the South

"I WILL not say that Birmingham will furnish the world with iron, but I will say that she will eventually dictate to the world what the price of iron shall be."

The words are those of Sir Lowthian Bell—father of the present Sir Hugh Bell—on the occasion of the Iron and Steel Institute's memorable visit to the United States in 1890. Things move rapidly in the iron and steel industry, and if the prediction was to be fulfilled it ought to have been realized long ere this.

Not that Birmingham has done nothing. The state of Alabama, which is really not the whole of the Birmingham district, produced 2,953,705 gross tons of pig iron in 1917, making a new record, when most districts fell behind their output of 1916. Alabama's 1917 production was 32 per cent of the tonnage the whole country produced in 1890, when the prediction was made, and 37 per cent of Britain's production in that year, but Alabama's contribution to the pig iron output of the United States was 8.9 per cent in 1890 and only 7.6 per cent in 1917, showing a decline of 15 per cent in the proportion.

The prophecy, however, related not to tonnage but to price. As to price, it is well recalled that in 1897 Birmingham sold pig iron at prices that made producers in other districts, at home and abroad, stand aghast. The average market quotation on southern pig iron at Cincinnati in 1897 was $9.33. The freight rate from Birmingham to Cincinnati was $2.75 to May 1, 1917, and $2.25 thereafter, and allowing for this the average quoted price at Birmingham furnace would apparently be $6.91, but the computation is misleading, in that in those days freight rates were cut. On the other hand, sales were made, particularly for export, at under the quoted market, and thus it is probably not far wrong to say that Birmingham pig iron sold in 1897 at an average price of $7. Exports from the United States in that year were 262,686 tons, a large part of the iron coming from the Birmingham district. Incidentally, the present government price is $33.

Birmingham was not dictating, but was being dictated to. Furnaces lost money, and if their books did not show it the fault was in the accounting. The fates, however, had been against Sir Lowthian Bell in his prophecy of 1890. After the Institute meeting in Pittsburgh the visitors toured the country. They were in the Lake Superior iron and copper region October 15 to 18, and shortly afterward they returned home. No sooner were they safely out of the country than Alfred and Leonidas Merritt, on November 16, 1890, discovered the Mesabi range. Two years later the first Mesabi ore was shipped. The story of the range is familiar. By simple stripping operations enormous quantities of exceptionally rich ore were obtained, and it was literally sold as cheap as dirt in 1897.

There are many remarkable facts about the American iron and steel industry. Two of them are: (1) No large fortunes, made on the outside, have ever been put into the industry, except perhaps in certain isolated cases when the money was lost in unsuccessful experiments; (2) Until shares in the industry were mobilized by being listed on the stock exchange, practically no large fortunes were taken out. Yet the industry has made enormous sums of money. The deduction is obvious. Throughout its growth it has required the investment of great sums of money. The investments have very rarely been successful except when made by those who made the money in the industry, and without large earnings for reinvestment the manufacturer could not maintain the pace.

In 1897 the South sold pig iron at phenomenally low prices, and lost money. At the same time the Carnegie Steel Company sold steel at phenomenally low prices, and made money. For a time it borrowed from nearly every bank in Pennsylvania. The Southern producers could not borrow in their banks.

The Mesabi range rose and fell. The ores it is now shipping are very much less rich than those which made its reputation, for those rich ores are exhausted. With all the refinements, transportation costs are high. The Southern ores are as good as they were, and as years pass the competitive position, as regards quality of ore and coke, will improve for the South. Capital it certainly will be able to command much more freely than hitherto. Labor conditions in the United States produced by the war necessitate that in the future there must be much wider use of labor-saving machinery than there has been in the past. That probably will be to the advantage of the South, where inefficiency or scarcity of labor has exerted a restrictive influence. The South still has the natural advantages upon which Sir Lowthian Bell based his prediction. If the Mesabi range had not been discovered the course of American iron and steel development in the intervening 27 years might have been quite different.

Readers' Views and Comments

Electrochemical Industry Essential to Winning the War

To the Editor of Metallurgical & Chemical Engineering

SIR:—The United States is now training over a million men to fight in France. Several million more will be trained. These men must have cannon, machine guns, rifles, shells, powder, cartridges, gases, airplanes, automobile trucks, and all other equipment of war in enormous quantities.

To manufacture these munitions high-grade alloy steel is necessary. For the preparation of the ferro-alloys used in making this steel existing electric furnaces are being worked to their utmost capacity. Numbers of new electric ferro-alloy furnaces are being constructed.

The vast quantities of abrasives which are so essential for the manufacture of machine guns, rifles, shells, automobile trucks, airplanes and all other machinery are almost all prepared in the electric furnace. In fact were it not for the electric furnace production of abrasives, it would be possible to produce only a small fraction of the vast amounts of machinery equipment for war purposes which are being turned out daily. The average man, unless he stops to consider the present manufacturing situation, has little or no conception of the fact that almost all fine machine work nowadays is finished in the grinder or with the use of abrasives.

For the manufacture of airplanes and auto trucks vast quantities of aluminium are required. This can only be manufactured by electrochemical processes.

Large quantities of the zinc necessary in manufacturing the brass used in the millions of cartridge cases made daily are recovered from the ore and purified electrolytically.

Many of the gases used for war purposes, i. e. hydrogen, chlorine, and bromine, are largely possible of preparation only by electrochemical means.

Many of the nitrogen compounds used for preparing the vast quantities of explosives required by our army and navy will be prepared with the aid of electrochemical and electrothermal processes.

Other basic materials such as magnesium, graphite, carbon electrodes, potassium chlorate, etc., which will be required in quantities can only be prepared with the aid of the electric furnace or electrolytic cell.

It is self evident to every thinking man that the electrochemical industry is essential to the winning of the war.

The war has resulted in a tremendous increase in interest throughout the country of all subjects having to do with chemistry and electrochemistry. The memberships of the scientific societies dealing with these subjects have increased tremendously. In view of these facts I think that your journal can well afford to emphasize the importance of the electrochemical industry to the country at large and also the fact that the interests of the electrochemical industry and the Electrochemical Society are identical, for in the Electrochemical Society are associated the men of the country who are pushing forward this work. Membership in the society affords the opportunity to stand shoulder to shoulder with the men, who foremost in their profession, are making it their business to see that the United States and her Allies receive the very best possible support from the electrochemical industry and all others related thereto.

The American Electrochemical Society is recognized as one of the livest scientific organizations in existence and is nationally renowned for the breadth of the discussions covering the papers and addresses presented at its two general meetings held each year in various parts of the country, which, combined with visits and special excursions to the more important centers of electrochemical developments are attended by the foremost electrochemists, engineers, metallurgists, chemists, manufacturers and central station men.

In existence for the past sixteen years, its membership of approximately two thousand extends throughout the entire world. Its literature is recognized as the only complete journal or "hand book" extant on the subject of electrochemistry. Its membership is open to those engaged in, affiliated with or interested in any way in electrochemistry and allied subjects.

The president of the society is Dr. C. G. Fink, well known for his development of the ductile tungsten used in the modern incandescent mazda lamp, and at present in charge of the research laboratory of the Chile Exploration Company.

The general secretary of the society is Dr. Joseph W. Richards, Professor of Metallurgy, Lehigh University, South Bethlehem, Pa., who as a member of the Naval Consulting Board is spending a large part of his time in Washington assisting with the work of this body, which by the way numbers among its members four past presidents of the American Electrochemical Society.

CARL G. SCHLUEDERBERG.

Westinghouse Electric & Mfg. Co.,
E. Pittsburgh, Pa.

Electrolytic Pickling of Steel

To the Editor of Metallurgical & Chemical Engineering

SIR:—In your issue of March 15 Dr. Carl Hering makes some criticisms of work by Mr. Dodson and myself which appeared in your Dec. 15th issue, on Electrolytic Pickling of Steel. I should like to reply briefly to these remarks.

Dr. Hering's first criticism is that the chemical pickling did not last long enough, thus dissolving less iron than would normally be dissolved. In a former article[1] the object was to carry out the process in such a way as to make the electrolytic method appear to the best advantage; in this article, to the least advantage, as stated in the first paragraph, with the idea that actual practice would lie within these limits. For this reason the pickling was not continued beyond the point stated, where the scale was all removed except some very fine particles that could be completely cleaned off by brushing.

[1]Tr. Am. Electrochem. Soc. 31, 181 (1917).

The second point is that in the chemical pickling the scale was filtered off before titrating the iron dissolved. In the first article all scale was dissolved before titrating; in this, none. In practice the results would lie between these two extremes.

The third criticism is that the acid was stronger than what Dr. Hering understands is used in practice in acid pickling, and not as strong as the patent calls for in the electrolytic pickling. Patent No. 827,179 states "good results" may be obtained with acid between specific gravities 1.15 and 1.25. Patent No. 855,667 recommends specific gravity 1.2. We used 1.19. I understand that 4.5% acid is used in chemical pickling. It was perfectly proper to use the strength that gives the best results in this comparison. This criticism is therefore entirely unjustified.

The fourth point is that the current density was not as high as called for by the patent. The patent (No. 855,667) calls for 40 to 70 amperes per sq. ft. Our current densities varied from 0.033 to 0.058 amperes per square centimeter or 30 to 54 amperes per square foot, averaging over 40 on the ordinary black plate; higher for the silicon-steel plates. This is within the limits specified by the patent. Dr. Hering's statement that the electrolytic process was not carried out properly is therefore not true.

Finally I believe these two investigations show the electrolytic method superior to the chemical method, and that this superiority increases with the thickness of the scale treated.

M. DE KAY THOMPSON.

Cambridge, Mass.

Electrolytic Pickling of Greasy Surfaces

To the Editor of Metallurgical & Chemical Engineering

SIR:—The question has frequently been asked whether grease or oil on the surfaces of the steel would interfere when the scale is to be removed by electrolytic pickling, and whether the pickling removes this grease also. It was thought that the oil, being an insulator, would first have to be carefully removed, as in electroplating.

The writer therefore made the following tests: A piece of ordinary sheet steel covered with black scale was used; before pickling and while quite dry, a small part was painted over with mineral lubricating oil; another part with soft tallow; another part with linseed oil; and another part with lard oil. These oils and the grease therefore represented mineral, animal and vegetable oils; in each case they were well rubbed into the surface. The rest of the plate was left free from all grease or oil.

It was then pickled electrolytically in the prescribed way, by the Reed process, and it was found that the scale was removed quite as perfectly and quite as fast from those parts of the surfaces which had been covered with oil or grease as from those which had not; the oil and grease had disappeared completely, and on the cleaned surface it was not possible to find any indications of which of the parts had been oiled. The test was repeated many times, always with the same result. The oil was put on in as thick a layer as would adhere to a vertical plate, and the tallow was put on thick enough to show white. One of the plates was removed for inspection every five seconds but there was no noticeable difference between the reduction on the oiled parts and on the others. It seems that the hot nascent hydrogen or the current itself removes the oil and grease very effectively.

On removing the plates the water did not seem to wet them, indicating that they got a film of oil on them from the oil which had gathered on the top of the bath; this is an advantage rather than otherwise; and presumably it would not interfere with the subsequent tinning as such tinning baths often have a layer of oil over them through which the plate must pass before entering the tin bath.

It follows therefore that oil or grease, no matter how thick the coating, does not interfere in the least with electrolytic pickling.

CARL HERING.

Philadelphia, Pa.

Analysis of Ferro-Silicon

To the Editor of Metallurgical & Chemical Engineering

SIR:—I am sending herewith a condensed method of longer standard methods for the complete analysis of ferro-manganese. I have been using this scheme of analysis for some time with very satisfactory results.

A one-gram agate-ground sample is dissolved in 30 cc. of concentrated hydrochloric acid with the addition of a few crystals of potassium chlorate, and the solution evaporated to dryness. Take up with dilute HCl and filter off the silicious matter. The filtrate is taken to dryness a second time to render the last traces of silica insoluble. The two precipitates are carried through the usual silicon analysis. To the filtrate add ammonium chloride and boil. Precipitate the iron with ammonia. Dissolve the precipitate in dilute HCl and re-precipitate the iron twice in order to render the last traces of manganese in solution. After the third precipitation and filtration dissolve the iron precipitate in dilute HCl and titrate the iron with potassium permanganate (N/10 solution). The combined filtrates and washings from the iron separation are made acid with HCl and brought to a boil; then add 15 cc. of a 25 per cent solution of sodium-ammonium phosphate. While the solution continues to boil and with constant stirring, precipitate by adding concentrated ammonia drop by drop until a silky white precipitate of manganese phosphate is formed, after which enough of the ammonia is added to make the solution faintly ammoniacal. Remove from the source of heat and allow to settle a few minutes. Filter on a weighed Gooch crucible, ignite and weigh as $Mn_2P_2O_7$. The factor for manganese in this compound is .3869. If there is an appreciable amount of residue left in the crucible after completing the silicon determination, it should be fused with fusion mixture and the manganese determined by the sodium bismuthate method. Any result so obtained should be totaled with the manganese percentage. The carbon content may be obtained by the usual combustion method.

M. A. MAMMEN.

Middletown, O

Further Hearings on Federal Water-Power Bill

SIR Adam Beck, chairman of the Ontario Hydroelectric Power Commission appeared before the special Congressional committee on water-power bills on April 15 and spoke for five hours on conditions in Ontario. The hearings before the special committee will not close until Secretaries Baker and Houston have been heard, and there is some delay in prospect before a final bill will be drafted and presented to Congress. Members of the House, however, express confidence in the passage of a bill at this session.

In his address to the committee, Sir Adam Beck traced the inception and development of hydroelectric power in Ontario, beginning with the granting of franchises to the Canadian-Niagara Power Co. for 100,000 hp.; the Electric Development Co. for 125,000 hp. and the Ontario Power Co. for 180,000 hp. In 1900 the Board of Trade of Ontario initiated a movement to secure development privileges for municipal purposes. This was not considered favorably by the legislature, but in 1902 an act was passed authorizing municipalities to borrow money for light and power development. Difficulties were encountered in raising money, and rights were granted to the Electric Development Co. which had affiliated with it the electric light and street railway companies of Toronto.

In speaking of the present hydroelectric commission of which he is chairman, Sir Adam said:

"We have power to acquire by purchase or otherwise, on any terms, and hold shares in any incorporated company carrying on the business of developing, supplying and transmitting electrical energy. We have power to appropriate the land, waters, water privileges or water powers or works, machinery and plants or portions thereof of any person owning or operating under lease or otherwise or operating or using water-power privileges or transmitting electrical power or energy in Ontario which in the opinion of the Commission should be purchased, acquired, leased, taken, expropriated and developed or used by the Commission for the purposes of the Act."

At the present time the Ontario commission has acquired about 86 corporations, all by friendly negotiations and without resorting to the drastic powers delegated for that purpose. Contracts are in force with 225 municipalities. The form of contract is standard in all cases; the municipality pays all interest charges at 4% and a sinking fund of 1.8% which retires in 30 years. They pay line losses, depreciation charges, cost of operation, administration, etc. The average cost of power delivered to 225 municipalities in Ontario is under $18 per hp. The average rate is 2½ cents per kw.-hr.

"We operate at the present time twelve systems. They will become interconnecting eventually and form one great trunk system. In this way we are attaining the object of the whole scheme, namely, unit control.

Believes in Monopoly of Water Power

"We want to create a real monopoly because we believe all these service undertakings should be a monopoly. There is little satisfaction in having competition in a telephone system, or a telegraph system, or even a railway system, and certainly not in an electric system in any community. The obnoxious poles and wires, the great dual cost of everything, and the great dual investment that results because of the diversity created by these various corporations covering the same field is undesirable from every standpoint."

As to the Niagara situation, Sir Adam said the principle laid down by the International Waterways Commission is that there should be an equal division of water for power purposes on all international streams, and pointed out that there is now pending an application that the United States Government shall confer with the Dominion authorities regarding a proposal to allot another 10,000 second-feet to each government. This, he pointed out, is advanced as a war measure, and will be justified even though the most efficient use is not made of the water. Sir Adam said he believes that if this measure is carried through it would not be canceled after the war, but that the allotments would be permanent. He presented figures to show that the total power now being generated on both sides of Niagara is 653,500 horsepower. Of this amount, 265,000 horsepower is generated in the United States, which also receives 110,000 horsepower exported from the Canadian side, making a total of 375,000 horsepower available in the United States. This amounts to 40 per cent. more for the United States than for Canada although the latter country generates 100,000 more horsepower than the United States.

Present Conditions Unfavorable to United States

Comparing conditions on both sides of Niagara with relation to the establishment of electrochemical industries, Sir Adam pointed out the necessity of stabilizing prices for the encouragement of industry and said that under present conditions he thought industries would be more likely to go to Canada than to the United States. He was strongly in favor of government control of water power and intimated that nationalized control on our side of Niagara would do much to foster electrochemical industry in the United States.

The chairman of the commission went on to say that there is no intention on the part of the Canadian government or on the part of the Commission to interfere with the present export arrangement, even though Canada is now short 100,000 horsepower of the amount that country needs. In order to permit a continuance of the export, Canada has arranged to do away with all sign lighting, window lighting, and other uses of energy which in some quarters have been characterized as less essential. He said the power generated by the Province of Ontario has reduced coal consumption between 5,000,000 and 6,000,000 tons per annum. Motive power has been saved, use of cars has been saved, and duty on coal has been saved. The estimated potential horsepower of hydroelectric energy in Canada, Sir Adam said, is about 50,000,000, and in Ontario alone about 5,000,000 or 6,000,000, with but 700,000 developed. At the beginning of the Commission's work, in 1910, only 750 horsepower was being delivered to the twelve municipalities.

Speaking of the purchase of the Ontario Power Co., Sir Adam said that the commission expected to own the plant in 25 years, paying for it out of revenue from contracts with municipalities and with the Niagara-Lockport Co. Present contracts are at $9 per horsepower for 100,000 hp., and at $12.50 with the Niagara-Lockport Co. for 60,000 hp.

Secretary Lane Urges Water-Power Development

The Secretary of the Interior Regards a Constructive Program as a Vital Necessity to the Conduct of the War as Well as for the Future Extension of Our Electrochemical Industries

IF THE Congress of the United States is willing to commit the country to a program of federal development of water powers I see nothing impracticable in government ownership and operation of such utilities," said Secretary Lane in an interview with METALLURGICAL AND CHEMICAL ENGINEERING on the water-power question. "But," he continued, "under present conditions it seems more likely that immediate results will be secured through private initiative, and inasmuch as the quickest possible development is needed for the benefit of our electrochemical and other industries, both for war and peace, I am in favor of encouraging such a program. Owing to the tremendous demands now being made on the Government for funds it would seem unwise to adopt a policy of government ownership at this time. On the other hand, since there is a genuine demand on Congress for hydroelectric development, it is the duty of the Government to lend every assistance and to pursue a policy of fair and reasonable treatment of those who are willing to take the risk of investing money in such enterprises.

FRANKLIN K. LANE

The opinion of Secretary Lane on this question was sought not only on account of the general importance of the subject, but also because of the Secretary's wide experience in the administration of water power and related projects in the Department of the Interior. Continuing he said:

"The electrochemical industries of the United States have been found particularly essential to the conduct of the war, and yet they have not had adequate power. If these industries are to be fostered in this country and their extension made possible, it will be necessary to provide more power; otherwise we are confronted with the expatriation to more favorable localities of those industries which should be established here. More power should be developed at Niagara, and I believe that the United States and Canada should enter into an agreement for a large international development there that will make one million horsepower available to both countries. It would seem quite as feasible to secure the necessary legislation for this purpose as to negotiate a new treaty allotting to each nation additional water for private development.

"It is not at Niagara alone, however, that we need to develop water power. Our program should encourage development throughout the country wherever there seems to be a necessity for it and wherever we have mineral resources contributory to electrometallurgical industries. Some time ago I had prepared by the Geological Survey a series of maps of the Southeastern United States, showing the mineral resources of that region. It so happens that this same territory is rich also in potential hydroelectric energy. Some of it is developed but more will be needed as our industries expand with the normal growth of the country. We should realize that we need to undertake these developments immediately to meet war needs as well as to provide for future expansion. We have already witnessed wonderful progress in our chemical industry since the war began, and I believe we are on the verge of still greater expansion which will put this country in the lead. Prudence and foresight dictate that we should develop our water powers *now* in anticipation of the industrial growth that seems right at hand.

"Our neglect of water-power development in the past has been absolutely criminal, and in our present emergency we are discovering what it would have meant to us to have a great national resource well in hand. At a time like this we need to throw every resource we possess into the balance, and we have been woefully lacking when it came to water power. Of course the conservation of coal is an argument for water-power development, because much of our coal is used wastefully, and once used is gone forever. We ought to conserve our coal and use it in such a manner as to recover all the useful chemical by-products. Coal that is adapted to making coke should be used for that particular purpose and not as ordinary fuel. Another argument is the need of hydroelectric power for transportation on railroads—a problem which even now threatens to become acute next winter with its attendant fuel troubles. But to my mind the logical argument for water-power development is the folly of allowing a great natural resource to run to waste when it might be made to contribute so much to our industrial prosperity in times of peace and our national security when threatened with war.

"I have been deeply impressed with the importance of the chemist and the electrochemist, both in peace and war, and I realize the value of their contributions in meeting the problems forced upon us in our present emergency. It has given me a glimpse of the expanding romance of those sciences, as well as a vision of what the future holds for this country if we develop our resources to the fullest extent."

Director Manning Shows Importance of Electrometallurgy

Director of U. S. Bureau of Mines Emphasizes Vital Relation Between Hydroelectric Development and Electrometallurgy. Sees Expansion in Future Application of Electricity to Metallic and Non-Metallic Minerals

IF one looks at the relief map of this or any other country he cannot but be impressed with the large area of the earth's surface which is covered by hills and mountains, and unsuited to agricultural purposes, as compared to that which is so suited. At first glance one gets the impression that this is opposite to what it should be; but if we take into consideration the fact that the agricultural land of the earth by judicious and careful attention, may be made to yield food products continuously from year to year, while our mineral deposits, if once worked out, are gone forever, we come to the conclusion that after all it is a wise provision of nature that the proportion of the hills and mountains to the tillable land is as it is. These same hills and mountains serve as storehouses from which may be taken as needed, the ores which furnish the iron and steel which is used in the construction of our railroads, our steamships, our great buildings, and our machinery of every sort. From these same hills come the ores of the rare metals used in giving steel its special properties; the copper so essential to the manufacture of our alloys, and above all to the transmission of the electric current which can be most readily generated by the power afforded by the cataracts and falls of the rivers and streams.

VAN H. MANNING

In this connection, it is also well to remember that this source of power is perpetual. Although our coal beds may be mined and consumed, and although our metallic resources may be depleted, the water power of the country is, except where affected by the destruction of the forests, as great today as when man first set foot upon the continent, and, so far as we are able to judge at present, should remain so until the end of time. Although man early learned to harness the power of the water-fall and put it to use, it was not possible until electricity had been discovered, and ways and means of transmitting it perfected, to utilize the power of the water-fall at any great distance from its source. As the science of electrical engineering was developed it became possible to transform the latent power of the mountain streams into electric power capable of being transmitted hundreds of miles to light our cities, propel the cars along the streets, turn the wheels of factories, and in general make modern life possible. Although the discovery of electricity and the application of electrical engineering has done all this for us, it has also made possible the conservation of our coal; in other words it has extended the life of our fuel resources, especially for mining and metallurgical purposes.

Naturally, I am particularly interested in its use for the latter purposes, due to the fact that one of the principal functions of the Bureau of Mines is to conserve our mineral resources. As is well known, the use of electricity is becoming more and more extended in metallurgical work. Moreover, as is also well known, the application of electricity to metallurgical processes is comparatively recent. It was not until 1882 that it was probably first used by Siemens in electrothermic work, and its first application on a large scale for electrolytic purposes was perhaps in 1886 by Heroult and Hall, who in that year patented their processes for the production of aluminium. As late as 1898 the work of Stassano in producing pig iron in an electric furnace was looked upon more as something spectacular than as forecasting the important part which the electric furnace was to play in metallurgical work in the future; and it was not until 1900 that ferro-alloys began to be produced in the electric furnace. Taking into consideration this fact, and also the fact that today practically all ferro-alloys are made in the electric furnace, and that there are now two or three hundred steel furnaces making the same high quality of steel that it was formerly thought could be produced only in crucible furnaces, one is impressed with the rapid growth of the use of the electric furnace in the ferro-alloy and steel industry.

Electrolytic processes also are finding a more extended application as evidenced by the growth of the electrolytic zinc industry. In this day and generation it is not safe to predict just what may or may not be possible; but judging from the rapid growth of the application of electricity to metallurgical work during the past 20 years, it would seem safe to prophesy that electricity is only beginning to be applied to winning metals and non-metallic products from their ores, and that it will not be long until electrical processes will be discovered and applied to the treatment of those ores to which they are not at present applied. This seems true especially in the southern part of this country, to be visited by the American Electrochemical Society.

Proposed Minerals Administration Bill

A Synopsis of H. R. 11259 for the Control and Administration of Certain Special Minerals With a Particular View to Stimulating Production to Replace Import. Reported Favorably to the House by the Committee on Mines and Mining

AS MANY of our readers are undoubtedly aware, the War Minerals Committee has deemed it wise and necessary to propose national legislation for the purpose of securing adequate supplies of certain minerals, hitherto largely imported, and now essential to the production of munitions or for war industries. Under the direction of the Department of the Interior and with the approval of Secretary Lane, a bill was prepared and introduced in the House. Subsequently, hearings were held on the bill by the Mines and Mining Committee, and a favorable report has been returned to the House. It is reported in Washington that the Senate is likely to propose a bill differing in important details from that of the House, and that further hearings will be held by the Senate Committee. There seems to be agreement on the purposes of the legislation, but disagreement as to the methods of accomplishment. For the information of the industry we give a synopsis and comment on the sections of the House bill as seen by its proponents. With but two or three exceptions, the hearings developed a favorable attitude toward the bill. Opposition developed to the feature of price-fixing and to the possible interpretation of the bill to include the ordinary metals of which some of the unusual metals are by-products. As a substitute for the plan proposed by the bill, it was suggested that the Government organize a mining corporation and engage in business for the purpose of securing needed metals.

In the face of higher costs, unstable prices, transportation congestion, labor problems, and new taxes, increased domestic production is not taking place at a satisfactory rate. The bill plans to meet this situation in two ways. First: To increase production by stabilizing market conditions and eliminating part of the risk due to the uncertainty as to the length of the war; and second: where domestic production is not possible, to control consumption and prevent waste and nonessential use.

No Governmental body now has the authority which must be exercised to stimulate domestic production and to control effective distribution and use of these mineral supplies. The bill has been modeled after the Lever Bill, under which the President formed the Food Administration. The circumstances which justified the passage of that act are almost identical with those which now threaten to reduce the supply of these essential minerals. The bill provides authority to encourage the production of ores and minerals and to conserve their supply, to assure equitable distribution, to improve and direct utilization, to prevent manipulation, speculation, unfair practices and unequal division of profits, and to lessen our dependence upon imported materials.

Section 1 enumerates the minerals and their products which are included under the jurisdiction of the bill and which are defined as "necessaries." The minerals included represent those which have been formerly imported and whose supply is now uncertain due to shipping conditions, and in addition certain special minerals for which the demand for military purposes may increase beyond our visible supply.

The bill specifically defines "only the following named mineral substances and ores, minerals, intermediate metallurgical products, metals, alloys and chemical compounds thereof, to wit: Antimony, arsenic, ball clay, bismuth, bromine, cerium, chalk, chronium, cobalt, corundum, emery, fluorspar, ferro-silicon, fullers earth, graphite, grinding pebbles, iridium, kaolin, magnesite, manganese, mercury, mica, molybdenum, osmium, sea salt, platinum, palladium, paper clay, potassium, pyrites, radium, sulphur, tin, thorium, titanium, tungsten, uranium, vanadium, zirconium, and of other rare elements."

Section 2 authorizes the President, through the Secretary of the Interior, to take such steps as are necessary to carry out the purposes of the act and to create the necessary organization for this purpose. In view of the fact that this work will be of temporary war emergency character and must be carried out with the greatest dispatch, it is provided that persons may be employed without reference to Civil Service laws and regulations, as has been done under similar administrations which have been created.

Section 3 prohibits the agents or employees of the Government who are engaged in the carrying out of the provision of this act from soliciting contracts or from taking part in the letting of such contracts where they may have any financial interest involved, and provides penalties for the same, and in addition the forfeiture of any profits accruing as result of any action taken contrary to the provisions of this section.

Section 4 is a general section making unlawful certain acts which are covered in detail in the succeeding sections.

Section 5 provides for the licensing of the manufacture, storage, mining, distribution, and use of the "necessaries" specified in the bill. The licensing power is one of the most effective and necessary instruments for carrying into effect the provisions of the bill. There is considerable latitude left as to the method of licensing so that it might be possible to license any branch of the industries concerned either by general proclamation or by the issuance of individual licenses to every concern. It is assumed that the licensing power will not be used except where necessary. Due to the limited number of persons or concerns engaged in the production and distribution of the minerals specified, the number of licenses will be relatively very small, and consequently this feature of the bill will not cause any great expense or difficulty of administration. For example:—There are not over a dozen producers of sulphur, less than a hundred producers of pyrite, and not over two or three hundred producers of manganese. The provision for entry and inspection by duly authorized agents is essential to secure the necessary information with regard to compliance with licensing provisions and information dealing with consumption and prices. Authority is given to determine and establish just and reasonable returns to the various parties concerned in the production and distribution of the minerals involved. It is designed to correct an unequal division of profits between miners, brokers, smelters, and manufacturers, in order to insure adequate prices to stimulate production and at the same time to prevent an undue enhancement of the prices of products to be consumed.

Section 6 defines hoarding as the accumulation of supplies in a quantity in excess of the reasonable requirements of the business or when accumulated for the purposes of manipulating prices.

Section 7.—Hoarding has been defined as an unlawful act and this section provides a method of procedure in cases in which hoarding has been committed. The power to requisition conferred in Section 10 does not infer that an unlawful act has been committed and there is no penalty attached. On the other hand, if hoarding has been willfully committed, the person may be guilty of a violation of the law and becomes subject to condemnation proceedings. The evidence of hoarding is a question of fact which must be determined by a court or jury.

Section 8 provides a penalty for the willful destruction of "necessaries" as defined in the bill.

Section 9 provides penalties for limitation and restriction of output. Since the purpose of the bill is to stimulate production, this Section is primarily designed to prevent willful limitation of the supply and will not, of course, apply to ordinary commercial factors which discourage production.

Section 10 authorizes the President to requisition "necessaries" when required for the successful prosecution of the war and provides the means for justly compensating the owner. The necessity for this section lies in the fact that essential industrial and military requirements must first be met and that persons must be prevented, where a shortage exists, from diverting their products to non-essential uses.

Section 11 gives power to buy and sell and to make contracts for periods of not exceeding two years. The inability of producers to secure long time contracts for their product has contributed more than any other single factor to hinder new development. Uncertainty regarding the duration of of the war and the trend of prices thereafter discourages investment in any enterprise which is primarily based on war demands. It is obvious that if the power of purchase is granted, the powers to provide storage facilities and to sell must naturally follow. As long a contract period as two years is deemed absolutely essential because of the time element involved in opening new mines which usually takes a minimum of from four to nine months. No new contracts can be entered into after the termination of the war.

Section 12 empowers the President to take over and operate mineral deposits and plants which are either idle or insufficiently developed. While this power should be used as a last resort, it must be available for emergency. Such, for example, as where a deposit cannot be operated because of litigation, where the owners might refuse to develop the property, or where, because of its inaccessibility, private capital would be unable to operate it. The primary purpose of the bill is to stimulate development of necessary minerals by private capital wherever possible. This section is necessary to take care of any case where the other methods of stimulation provided might fail and where the output was essential. The section provides for the return of such properties as soon as the war necessity is over and for just compensation for any damage or depletion which may occur.

Section 13 provides for regulations to prevent speculation, manipulation of prices and unfair or misleading market quotations related to the minerals enumerated in the bill, and provides penalties for willful violation of such regulations.

Section 14 grants power to establish a guaranteed price in order to insure a reasonable profit to the producer and thereby stimulate production. Such guaranteed price may be for a period of two years. Considering the time element necessary to develop new mines and plants, two years is only a fair and reasonable time. Any shorter period would fail to accomplish satisfactory results in many cases. Sufficient latitude is allowed through regulations which may be prescribed in the establishment of guaranteed prices to make possible a sufficiently flexible handling of the problem to secure the best results. This section provides that duties may be placed upon the import of "necessaries" sufficient to bring the price of the imported article to the same level as any guaranteed minimum price which may be established under the bill. This provision is put in the bill for the purpose of protecting the United States Government. The Government having once established a guaranteed minimum price must, to make it effective, purchase such ores as are offered at that price, for the period of the guarantee which may be two years. In case of a sudden ending of the war, foreign "necessaries" might be imported at lower prices, unless this provision were made, thereby compelling the Government to purchase all domestic material at the higher guaranteed prices and increasing the liability of the Government to this extent. This Section further provides the power to fix prices. The establishment of a guaranteed price is essential to stimulate production, but additional price-fixing powers are necessary in order effectively to secure reasonable prices in any intermediate transactions between the producer and consumer. The section further provides that rules and regulations can be established with regard to methods of conducting business as supplemental to the licensing powers granted under Section 5. The necessity for control over methods of manufacture arises out of the possibility of a change in raw materials, or a scarcity of certain kinds of raw materials, or the use of substitute materials, which may require a change in practice. For example, in the steel industry it may be essential to revert to former practice and extend the use of the lower grade manganese alloys in place of the higher grade alloy formerly used which requires higher grades of ore than many of our domestic deposits will furnish.

Section 15 authorizes the curtailment of non-essential uses of the minerals covered in this bill in case a shortage of supply occurs which necessitates such action. For example, under this section it would be possible to prohibit the use of platinum in jewelry, or stop the use of tin for containers of dry substances.

Section 16 imposes a penalty for resisting an officer or employee enforcing the provisions of this bill.

Section 17 provides an appropriation of $500,000 for the administration of this Act.

Section 18 provides an appropriation of $50,000,000 to carry out the general provisions of this Act. This $50,000,000 is, in fact, a working capital which will enable the Government to enter the market and buy and sell the mineral products specified and to purchase any material which may be offered under the guaranteed prices established. This sum is not too large for the purpose, in view of the large liabilities which might be assumed under the bill. The value of the mineral products involved in the bill would be, at least, several hundred million dollars. While it is not contemplated that it will be necessary for the Government to actually purchase any considerable amount of the products whose prices may be guaranteed, a sufficient fund must be available to meet any possible contingency.

Section 19 provides that no employee under this Act is exempt from the provisions of the draft law.

Section 20 provides for annual reports of work done and details of expenditures.

Section 21 provides that if any part of the Act be declared invalid, such judgment shall not affect any other part of the Act.

Section 22 relates to the interpretation of the Act.

Section 23 provides for the termination of the provisions of this Act as soon after the close of the war as, in the judgment of the President, the agencies created can cease their activities and turn business back into its regular channels. While it is provided in Section 11 that no new contracts can be entered into after the termination of the war, it is obvious that it will take some time to settle the liabilities which may be contracted under the provisions of the bill and that consequently some organization will be required to terminate such business.

Bunker Hill Smelter Suits Ended

The suit filed last fall by the American Smelting & Refining Co. against the Bunker Hill & Sullivan Mining & Concentrating Co., and reviewed in our issue of Oct. 15, 1917, has finally been settled. Justice Wolverton at Portland has granted the preliminary injunction asked by the A. S. & R. Co., prohibiting the Bunker Hill company from smelting any of its own ores containg between 30 and 70 per cent lead. According to Stanley A. Easton, general manager of the Bunker Hill company, the adjustment provides for the future of this company. By its terms the ore produced will be divided equally between the two companies. Under the terms of the old contract the A. S. & R. company received ore containing 30 to 75 per cent lead, and the Bunker Hill retained ore having higher and lower contents. About 7500 tons a month will be available for division under the terms of the new agreement. The old rates charged by the A. S. & R. company have been readjusted so that the Bunker Hill will receive payment for a full 90 per cent of the lead content based on New York quotations and the grade of ore instead of the usual Coeur d'Alene contract, which provided for a split in price above $4.10 to the 100 pounds. The documents have been signed and the new arrangement will become effective at once. The suit will be dismissed if it has not been so disposed of.

SITE OF DAM NUMBER THREE, MUSCLE SHOALS

Nature's Gift to the Electrochemist at Muscle Shoals

BY WILLIS G. WALDO

AFTER a ten years' struggle with the obstructionists and pseudo-conservationists, the 660,000 horsepower which since the dawn of the present geological era has been running to waste in the Tennessee River is about to be developed. That ten years should have been required to secure the development of this power is evidence which points with great emphasis to the difficulty of bringing fundamental economic truths to the intelligent understanding of the busy business man. If, for example, the city of New York could witness a 100,000-pound capacity car fully loaded with coal taken to a prominent dock and dumped into the Atlantic Ocean, could see this carload of coal followed by a similar car ten minutes later, and could see this performance repeated at ten-minute intervals thereafter, continuously, day after day, it may be safely stated that this waste would not long continue without a vigorous protest from thousands of citizens. But let these cars of coal be wasted at the rate of five tons per minute in the dashing waters of a great river by reason of its lack of development, as is true at Muscle Shoals, and let this water power be located in a section of the country more or less remote from public view, and ten years are required to bring about the necessary action to stop the waste.

But it has been accomplished, and under the direction of Col. Hugh L. Cooper, builder of the great Keokuk dam and a man of international engineering reputation especially in hydro-electric development, the first of the two great power dams is about to be constructed at Muscle Shoals in the Tennessee River. Before considering the significance of this undertaking to the American electrochemical industries a consideration of the dams themselves may be of interest.

Outline of Complete Project

The full project calls for three dams. Number one is a small structure, 15 feet high and 300 feet long, provided solely for the purpose of improving the navigable channel.

The greater of the power dams is Dam Number Two, about 104 feet high and 4500 feet long, which together with its 850-foot power house will contain 1,200,000 cubic yards of concrete. When it is remembered that the great Roosevelt dam on the Salt River in Arizona, 260 feet high and 680 feet long, contains only 240,000 cubic yards of concrete, and the new Croton dam of the New York water supply, 1200 feet long, contains 855,000 cubic yards of concrete, something of the magnitude of this greatest of concrete dams will be appreciated. According to present plans approved by U. S. Army engineers, the ultimate installation at Dam Number Two will amount to 480,000 horsepower and the electrical units will be giants in size, developing 40,000 horsepower each.

Fifteen miles upstream from Dam Number Two is the site of Dam Number Three, which though but 40 feet high will be 6425 feet long, making it the longest dam in the world, for its length will exceed that of the great Assouan dam in the Upper Nile by 25 ft.

The motto of the famous builder in his construction work on Dam Number Two consists of but one word—Economy. The government has already provided for the emergency plants for the manufacture of nitrate at Muscle Shoals which will be driven by steam power and therefore it is regarded as unnecessary to increase the cost of the hydro-electric development by reason of undue haste. The government investment therefore will be held down to the lowest possible figure.

With respect to the cost of the power when developed it may be stated that estimates approved by U. S. Army engineers have placed the cost between $7 and $9 per horsepower-year, or less than 1½ mills per kilowatt-hour. This is contrasted with the cost of power at Niagara Falls which ranges from $10.50 to $20 or more per horsepower-year, or from 1.6 mills to upward of 3 mills per kilowatt-hour. True, industries already established at Muscle Shoals may require as much as 260,000 horsepower of this supply but it seems entirely likely that with the completion of the Muscle Shoals project 400,000 horsepower will be made available for the use of other industries at a remarkably low rate.

Retaining America's Leadership

It is well known that America leads the world in electrochemical products. Others may dispute American claims for leadership in other branches of chemical science, but in the field of electrochemistry and electro-

metallurgy the United States is admittedly foremost. The war is bringing to the American public a knowledge of the value of electrochemistry and electrometallurgy in a terrible lesson that will not soon be forgotten. Ignorance and indifference to the value of these key industries to our national welfare and existence have been responsible for conditions which have driven many important American electrochemical enterprises to other countries. As long ago as 1907 the American Cyanamid Company, after strenuous endeavors to secure a location on one of our great Southern power streams, was compelled to withdraw from the country entirely and locate on the Canadian side of Niagara Falls. Since that time hardly a year has passed that some important industry has not sought its greatest essential—cheap power—in the bleak northern lands of Canada and Norway.

But it now seems evident that the enlightened public opinion in America will assure our electrochemical industries that the supremacy which they have gained in spite of these handicaps shall not be taken from them, and evidence is not wanting in Washington that there is a growing appreciation of the value of Southern water powers and Southern resources in the expansion of these great industries.

SITE OF DAM NUMBER TWO, MUSCLE SHOALS

If throughout the length and breadth of the country Nature has provided a happy combination of advantages for the electrochemist, it is in the Southern Appalachians and the adjacent territory. Here is an abundance of water power, closely associated with mineral and other natural resources which for variety have no equal within a similar area elsewhere in the United States. From the Potomac on the north to the Alabama on the south there is not a single important Southern stream that is without its power section, and developments have been many, particularly in southern North Carolina, northwestern South Carolina and northern Georgia.

But while the eastern slope of the Appalachians is drained by a score of streams, the western slope is drained almost entirely by the many small streams which unite to form the majestic Tennessee. So it happens that the greatest of the power streams of the Southern states is the Tennessee River, and the greatest undeveloped power on the Tennessee River is at Muscle Shoals in northern Alabama where reliable government records covering a period of 72 years assure a conservative basis for dependable hydro-electric development. The advantages of this location for the electrochemist become evident when we inquire into the needs of electrochemical processes for producing the essentials that we all now know are among our most important national requirements.

Essential Electrochemical Industries

First and foremost we need within our borders, and preferably within the safety area fixed by the War College, the necessary plants for the fixation of nitrogen to provide nitric acid and ammonium nitrate for explosives, dyestuffs and fertilizers. The only method of nitrogen fixation which has seen commercial success on this side of the Atlantic is known as the cyanamid method, and no stronger endorsement for Muscle Shoals can be brought forward than the fact that here the government is expending $30,000,000 in a vast establishment for the fixation of nitrogen by this process. Other processes are also under development by the government at this point but it is a source of gratification that while developing these untried processes the government is proceeding along adequate lines by employing a well-known method in order to secure its immediate requirements.

The growth of the electric steel industry in the United States has been most remarkable. With but 42 furnaces in operation and building in January, 1915, there were 233 by the end of 1917, and America has become the leader of the world in electric steel manufacture, outdistancing all competitors by a wide margin, for Great Britain comes second with 150 electric furnaces installed and in operation in 1917.

Of especial value is cheap power in Southern steel making. For many years the South has labored under a severe disadvantage because of the high phosphorus and high sulphur content of its ores, because in making steel by the Bessemer process these impurities could not be satisfactorily removed. But the advent of the electric furnace equipped with an abundant supply of cheap power promises to revolutionize steel making in the South, for this furnace used for refining the molten charge of the open-hearth furnace yields an electric steel which acknowledges no superior and finds an equal only in the high-priced crucible steel.

Muscle Shoals is surrounded by iron ores of great richness and the reserves are estimated in the hundreds of millions of tons. For many years the Muscle Shoals locality has had its blast furnaces, and during the past year it has shipped many tons of pig iron to Illinois by water at less cost and in less time than the shipment could have been handled by rail. In shipping this iron in pig form to the Northern manufacturer, this section has but followed the economic error of other parts of the South, for it must be admitted, though without credit to the South, that the shipment of raw material from this section to other localities has been the common practice. With the advent of cheap power, with an abundance of raw materials, and with the unexcelled supply of labor, the time seems not far distant when the South will do far more of its own manufacturing.

Among electrically reduced metals, aluminium is claiming a most important part in meeting war requirements of the past few years. Aluminium manufacturers have been compelled to ship their raw materials from Arkansas to St. Louis and thence to Niagara Falls, more than a thousand miles, for reduction. Bauxite is found in many places in the South, for while the largest production in the United States is found in Arkansas, there are important deposits in Georgia, Alabama and Tennessee, and the development of cheap power at Muscle Shoals should make possible the establishment of a great aluminium industry in this vicinity.

A rival of aluminium that promises to surpass it in usefulness for many purposes is magnesium, which can be alloyed to produce a material as light as aluminium and yet, according to Dr. Fink, as strong as soft steel. The country rock in the Tennessee valley is largely magnesian dolomite, and one of the interesting problems for the electrochemist is the recovery of this promising metal from this tremendous supply of raw material.

Proximity of Power and Raw Materials

Equally fascinating is the recovery of potash from the high-grade potash feldspars which are abundant throughout the Southern Appalachians, and on good authority it may be stated that this problem has been reduced to one of the cost of power alone.

Valuable service has been rendered by the electric current in the refining of metallic zinc and the experience of the American Zinc Company at Mascot, Tennessee, is evidence of what is in store for the electrochemist when the South's resources are scientifically investigated. For many years the deposit of zinc at Mascot was regarded as comparatively unimportant but with the increasing demand and higher price of the metal the American Zinc Company undertook systematic drilling to investigate its properties and developed reserves of ore which justified the installation of a great modern concentrating plant. This is the type of investigation which is sorely needed in the South. We have had far too much guessing in dealing with our raw materials and the many disappointments which are charged against Southern developments may be fairly said to have been largely due to a lack of systematic investigation.

Those aristocrats of the metallurgical trade, the ferro-alloys, sometimes shipped by express in carload lots in these days of great demand, have already become established in the valley of the Tennessee. Both ferrosilicon and ferro-phosphorus are made in quantities within a comparatively short distance from Muscle Shoals although neither industry enjoys the advantages of $9 power.

High-calcium limestone and coking coal, so necessary for the manufacture of calcium carbide, are available in abundance, and cheap salt from the wells of West Virginia and from Louisiana provide the basis for chlorine, caustic alkali, sodium and a long line of other electrochemical products. The graphite fields of Alabama, hardly 150 miles from Muscle Shoals, afford a large and increasing supply of the raw material for electrodes, and the vast beds of phosphate rock hardly 60 miles from the Shoals, and which will soon be available by water transportation, offer to the master of electrochemistry a wonderful opportunity in the manufacture of phosphorus fertilizers and phosphorus metal.

In fact it is only necessary to refer to the map to observe the multitude of centers of commercial production of raw materials useful in electrochemistry and electrometallurgy which are found within the territory adjacent to the great power site at Muscle Shoals. Study of Southern resources has developed the fact that if a circle of 300 miles radius be drawn with Muscle Shoals as a center it will embrace a greater variety of commercially produced raw materials than is to be found in a similar area anywhere else in the United States.

LIMESTONE QUARRY SITE NEAR MUSCLE SHOALS

And when to an abundant supply of cheap power of great dependability and a large variety of raw materials there is added mild climate with its freedom from ice troubles in the power plants and where living is cheaper than in the more rigorous latitudes, and an abundant supply of suitable labor—for Muscle Shoals with its great government cantonments has already become an important labor center—and when it is remembered that here in great variety are factory sites having direct transportation by rail to nearby markets, north, south, east and west, and connection by water with the 14,000 miles of navigable streams which comprise the Mississippi River system, then it may be realized in a measure how commercially advantageous to the manufacturer is the location of Muscle Shoals.

Incombustible Celluloid in Japan.—According to Commerce Reports a noncombustible substitute for celluloid has been invented by a professor in a Japanese university, and a company has been organized for its manufacture. The factory buildings are now in course of construction, and it is planned to begin in April of this year, or soon after, the manufacture of waterproof cloth, and composition tiles, buttons and insulators. As soon as machinery ordered in the United States arrives, the manufacture of imitation leather, Linoleum, stained glass, marble, lacquers, and varnishes will be started. Patent rights have been obtained for linoleum, stained glass, marble, lacquers, and varnishes Japan and have been applied for in foreign countries.

Production of Electrometallurgical or Electrochemical Products Per Kilowatt-year*

VERY frequently the problem arises: A waterfall of x hp. is to be made available through transformation into hydro-electric power for the production of electrochemical or electrometallurgical products. What tonnage of products will it be possible to produce?

In a general way, on the shaft of the turbines only 80 per cent of the power of the waterfall is generated, calculated from its height and volume per second, this volume being carefully ascertained by an average annual figure resulting from numerous gaugings for rivers not provided with dam-reservoirs.

A new figure is next obtained by taking into account the losses suffered by the current before being utilized in the electric furnaces or in the electrolytic vat.

10% (on 80%) in dynamos, balance..... 72%
1% (on 72%) in the transmission line, balance 71.28%
3% (on 71.28%) in transformers 69.14%
1% (on 69.14%) in conductors 68.45%

Finally, supposing a waterfall of 5000 hp. is available, the current actually utilizable at the terminals of the furnaces or vat does not amount to more than $5000 \times 68.45 = 3422.50$ hp. Besides, in any electrochemical plant a number of accessory machines are used for the purposes of manufacture. For instance, in a calcium carbide, or ferro-silicon plant, there will be found crushers and grinding mills for both raw materials and finished products, conveyors, pumps, not mentioning even dynamos for lighting purposes, etc. All these apparatus are driven by electric motors which consume current amounting to one-tenth the power available at the plant. The figure of 3422 hp. is thus finally reduced to 3000 hp. and, of the 5000 hp. water power, only 60 per cent, or 2200 kw., is actually available for manufacturing purposes.

Supposing the current to be applied for the manufacture of electrochemical or electrometallurgical products, what can be obtained from one kilowatt during one year? To begin with, a statement must be made as to what is meant by the expression "kilowatt-year." It is not the power of one kilowatt utilized during 365 days of 24 working hours or 8760 kw.-hr. Actually, owing to accidents, inevitable interruptions for the inspection of the machinery, repairs, etc., even in plants intended for continuous operation, work is carried out during only 8000 hr. per year, and, thus, one kilowatt-year is equivalent to 8000 kw.-hr.

In the case of a plant which disposes of 2000-3000 kw. the following outputs may be obtained per kilowatt-year (meaning 8000 kw.-hr.):

Calcium carbide.....1600-1800 kg.

The output is reduced to 1000-1200 kg. in case small furnaces are used and is invariably above 1800 kg. in the large-sized furnaces consuming each 5000 to 6000 kw.

Ferro-silicon with 50% Si.....1000-1100 kg.

These figures are reduced to 1000 kg. with 1000-kilowatt furnaces operated with anthracite or coke. On the other hand, the figure is raised to 1200 kg. and even 1400 kg. with charcoal-operated furnaces.

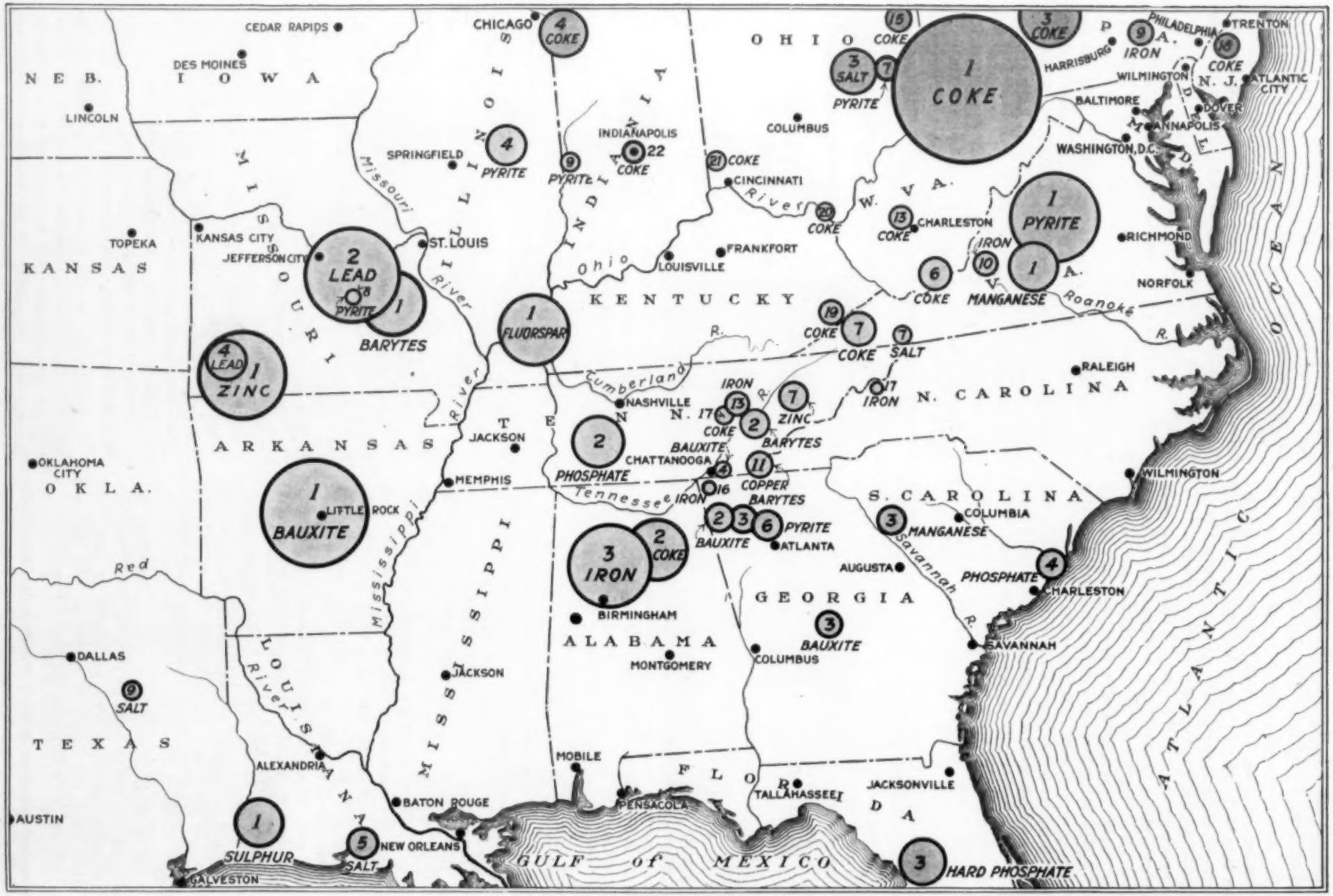
Ferro-silicon with 75% Si.....500-600 kg.
Ferro-silicon with 90% Si.....350-400 kg.
Ferro-chromium with 8% C.....800-900 kg.

This output diminishes rapidly according as the carbon-content is lowered since this is effected by successively remelting the high-carbon alloy in presence of chromium-bearing ore.

Ferro-nickel with 50% Ni.....300 kg.
(By reduction of an ore carrying about 5% Ni)
Ferro-tungsten with 50% W.....1000 kg.
Ferro-molybdenum .....900 kg.
Ordinary aluminium with 98-99% Al.....250-270 kg.
Aluminium nitride with 20% N.....1500-1800 kg.
Carborundum (crystallized).....300 kg.
Carborundum (amorphous).....500-600 kg.
Calcium nitrate (synthetic).....350 kg.
Caustic soda (electrolytic).....6-8 tons (metric)
Potassium chlorate.....6-8 tons (metric)
Chlorine (electrolytic).....6-8 tons (metric)
Pig-iron (high grade).....3-4 tons (metric)
(Starting from rich 50-60% ore and according to the nature of the reducing agent, whether coke or charcoal.)
Pig-iron (synthetic).....10-12 tons (metric)
(Obtained from steel turnings.)
Pig-iron (synthetic).....8-10 tons (metric)
(Obtained from a mixture of crop-ends, turnings and ore.)
Tool-steels .....20 tons (metric)
(Obtained from a liquid charge.)
Steel, high-grade carbon.....10-12 tons (metric)
(Obtained from a cold charge.)
Steel, refined in the electric furnace, 35-45 tons (metric)
(Obtained from a basic steel poured directly from converter into the electric furnace. The figure of 40 tons is double in acid operation, or .....80 tons (metric)
Steel, ordinary grade for casting..12-15 tons (metric)
(Cold charge with turnings.)
Iron, pure, electrolytic.....2 tons (metric)
Zinc, by electrothermic reduction.....1200 kg.
(Obtained by reduction of the ore in the electric furnace.)
Zinc, electrolytic.....2 tons (metric)
(Obtained by electrolysis of a solution of zinc salts from ore analyzing 30% Zn and 15% Pb.)
Copper, electrolytic.....90-95 tons (metric)
(Obtained by electrolytically refining crude copper.)
Copper, electrothermic.....2-3 tons (metric)
(By treatment of ore carrying 25% Cu.)
Sodium, metallic.....550 kg.
Calcium, metallic.....140-150 kg.
Manganese, pure.....140-150 kg.
Ferro-manganese, electrothermic.....10 tons (metric)
Silico-manganese and silico-spiegel...10 tons (metric)
(Output varying considerably according to composition of alloys.)
Magnesium .....300 kg.

In conclusion, it will be restated that these figures are only relative, being essentially a function of the skill put into the operations, of the size and type of the apparatus, and, frequently, of the nature of the current.

*Translated from Jour. du Four Electrique 1918, March 1, vol. XXVII, pp. 49/50



RESOURCE MAP OF SOUTHERN STATES

Adapted from a Complete Map of the United States Prepared by the Nashville Section, Engineering Association of the South

RESOURCE MAP OF SOUTHERN STATES
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Mineral Resources of the Appalachian South

A Symposium by Southern State Geologists on the Raw Materials Suitable for Chemical, Electrochemical or Metallurgical Development

A GLANCE over a map of the Southern States such as appears on the opposite page, on which has been indicated the location of important mineral-producing districts, will visualize clearly the importance of the Appalachian South in our present and future industrial life. Only the most important mineral products are here shown, but the full significance of the resources of this region can be gathered from the fact that of the 57 useful minerals produced in the United States every one is mined in the South except platinum and borax. Owing to the limitations of space the map does not show the pebble phosphate district of the Florida peninsula, which is first in importance in this country. The numerals in the shaded areas in the map indicate the relative importance in the United States of the regions producing the several mineral products. It will be seen at a glance that the area shown leads in the production of coke, pyrite, manganese, fluorspar, barytes, zinc, bauxite, sulphur and phosphate (not shown).

In an address on the industrial resources and opportunities of the South delivered by A. D. Little before the American Chemical Society at New Orleans, April 1, 1915, the speaker gave the following concise summary of the industrial position of the South:

"In general it may be said that the South to-day is in a far stronger position industrially than the entire country was in 1880. It cuts more lumber, mines nearly twice as much coal, produces nearly four times the petroleum, and nearly six times the spelter. It has more looms and spindles and a much larger investment in manufacturing plants. Its agricultural capital is greater and the products of its farms are worth fifty per cent more. It makes nearly twice as much pig iron and twice as much coke as the whole country produced only thirty-five years ago."

In another article in this issue by Richard K. Meade a comprehensive statement of the South's mineral resources is given and in the following paragraphs we present more detailed statements.

Mineral Resources of Alabama of Chemical and Metallurgical Importance

BY EUGENE A. SMITH
State Geologist

These resources are here presented in the order of their relative commercial value.

Coal and Coke.—The Warrior field contributes about 84 per cent of the total production, mainly from the Brookwood, Pratt and Mary Lee groups, which produce most of the coking coal and more than half of all the coal mined in the state. The Cahaba field contributes something over 12 per cent of the state's total, and the Coosa field about 4 per cent. The total production of coal in Alabama in 1916 was valued at $24,859,831. The coke production was valued at $13,019,139, and the coke found local use in furnaces of the companies manufacturing it. Of the value above given $3,828,057 is credited to bee-hive ovens and $9,191,082 to by-product ovens. Of these the Tennessee Coal, Iron and Railroad Co. at Ensley operates 240 Semet-Solvay ovens, and at Fairfield 280 ovens of the Koppers type. The Woodward Co. operates 170 Koppers and 60 Wilputte ovens; the Central Iron & Coal Co. at Holt have 60 Semet-Solvay ovens active, and the Gulf States Steel Co. at Alabama City have in operation 37 Koppers ovens. These establishments, in addition to the coke, turn out tar, benzol, toluol, naphtha, ammonium sulphate and naphthalene, with a value about equal to that of the coal used.

Iron Ores and Pig Iron.—The iron ores in 1916 were valued at $10,843,231, and the pig iron produced from them was valued at $38,994,660, an instructive illustration of the great increase in value of even the first derived product over that of the raw material. Roughly speaking the red ore or hematite of the Clinton or Red Mountain formation constitutes something over 80 per cent of the total iron ore production of the State. The most important development of this ore is on East Red Mountain between Birmingham and Bessemer, but other important occurrences are around

Attalla and Gadsden, and localities to the northeastward. The soft red ore, as delivered to the furnaces, contains on an average, metallic iron 50.80, silica 18.50, alumina 3.65 and lime 1.20 per cent, while the hard or limey ore carries metallic iron 37.00, silica 13.44, lime 16.20, alumina 3.18, carbonic acid 12.24. When the lime content of the ore is equal to the sum of the silica and alumina the ore is self fluxing.

HIGH-GRADE POTTERY AND PAPER CLAY, BED 15 FEET THICK, LANGLEY, SOUTH CAROLINA

The brown ore, in 1916, represented about 18 per cent of the State's production. The usual mode of occurrence is in irregular concretionary masses in residual clays resulting from decay of Paleozoic limestone in the Appalachian valleys.

An average analysis of a good quality of brown ore as delivered to the furnaces in Alabama, is, as follows: Hygroscopic and combined water, 13.00; metallic iron, 48.54; silica, 11.22; alumina, 3.61 per cent.

Limestone, Clay, Lime and Cement.—The chemical and metallurgical uses of limestone are for Portland cement, for furnace flux and for lime-burning. The limestone for these purposes in 1916 represented a value around $2,000,000, the Portland cement industry claiming a good deal more than half of this value. At present only two Portland cement plants are active in Alabama, viz., the Standard Co. at Leeds and the Coosa Co. at Ragland, both utilizing the Trenton limestone and the Clinton and Mississippian shales occurring in close proximity. The Demopolis Co., utilizing limestone of the Selma chalk, and its residual clays, is at present inactive. A future possibility for this industry in the Coastal Plain region is in the St. Stephens limestone with nearby clays of Grand Gulf age.

The stone for furnace flux for many years was from the Trenton and Mississippian formations, but in the Birmingham District the dolomite of the Knox formation has been found to be superior to the limestone and is in general use. The average composition of the limestone is silica 3.50, oxides of iron and aluminum 1.00, carbonate of lime 94.6 per cent. The average composition of the dolomite is silica 1.25, oxides of iron and aluminum 1.00, carbonate of lime 54.0, carbonate of magnesium 43.00 per cent.

For lime-burning the stone of Trenton age is very generally used, the center of the lime-producing industry being in Shelby County, between Pelham and Calera. Other important plants are in Etowah and Jackson and Lee counties, the stone at the latter place is a crystalline dolomite of undetermined age. This lime, used for chemical, agricultural and building purposes represented in 1916 a value of nearly $300,000.

The chemical and metallurgical uses of clay are practically confined to the Portland cement manufacture and to the production of fire-brick used in the furnaces, statistical figures for which are not available.

Graphite.—The graphite field in Alabama extends from Chilton through Coosa and Clay counties into Randolph. The ore is a mica chist with average content around 3 per cent graphite. The most important developments at present are around Ashland in Clay county with, however, notable activity in Chilton and Coosa counties. The graphite industry has shown a remarkable development. Up to 1913 the production was less than 1,000,000 pounds from two or three companies. From 1913 to 1916 the number of active companies increased from two to seven, and the production from 2,020,000 to 5,226,940 pounds. In 1917 twenty-one companies were active, and in 1918 up to April 1, twenty-four companies were active producers, but we have not yet the figures of production. All the Alabama graphite is shipped into other states and used chiefly in the manufacture of crucibles and for foundry facings. Recent experiments have shown that the Alabama flake graphite can entirely replace the Ceylon mineral in the manufacture of crucibles.

STRIPPING BED OF SEDIMENTARY KAOLIN NEAR AIKEN, SOUTH CAROLINA

Pyrites.—At the present time known commercial deposits of pyrites are confined to a very limited area near Pyriton in Clay County where the ore, associated with an altered ignesous rock, occurs in lenses of varying size, averaging perhaps 10 to 14 feet in thickness of the ore, which in part is shiping ore, but in part needs concentration. A thin band in the orebody carries a small percentage of copper. For some years previous to 1917 there was no production of pyrites in Alabama, but in the year named three companies have been active, but the production is not yet available. Near Hightower in Clebourne County, a vein of copper-bearing pyrrhotite has been worked for copper, though nothing has been done here for many years.

Barytes.—Occurrences of barytes of commercial promise have been observed in Calhoun, Selby, St. Clair, Jefferson and Bibb Counties, usually in the red

residual clays from Trenton limestones and in the fissures in these rocks. The crude ore is shipped to outside markets, no barium products or barium chemicals being manufactured in the State. The production in 1916 by four operators was 7631 short tons, valued at $27,198.

OPEN CUT BARYTES MINE SHOWING SIX-FOOT VEIN OF ORE AFTER STRIPPING, KINGS CREEK, SOUTH CAROLINA

Bauxite.—The known commercial bauxite deposits of Alabama are in Cherokee, Calhoun and DeKalb Counties, where it occurs generally associated with kaolin in pockets, mostly near the base of quartzite ridges and bordering red-clay areas that have resulted from the weathering of Knox dolomite.

There being in 1916 and for several years before that, only one producer of bauxite in Alabama, the tonnage cannot be revealed. The raw mineral is shipped out of the State for the manufacture of metallic aluminium, aluminium salts, abrasives and refractories.

Mica.—Mica mines were opened in Alabama during the early days of mica mining in the Southern states. Considerable developments have been made at intervals during the last 20 years in most of the counties of our crystalline schist areas. In 1915 and 16 sheet mica of excellent quality has been produced valued at between five and six thousand dollars.

Mineral Resources of Georgia

BY S. W. MCCALLIE
State Geologist

The mineral resources of Georgia are both varied and extensive. The state is producing at present 34 different kinds of minerals in commercial quantities. This great diversity of mineral resources is accounted for in a large measure by the great diversity in the geological formations.

Asbestos.—The asbestos deposits of Georgia are chiefly to the Piedmont Plateau, where they are found associated with dark-colored, igneous rocks. There are two varieties of asbestos, the chrysotile and the amphibole.

The latter variety is extensively mined in Habersham and White Counties, near Nacoochee, this state. The White County mines here referred to have been the chief producers of asbestos in this country for several years.

Barytes.—The Georgia barytes deposits, which have so far been worked in a commercial way, are located near Emerson, Bartow County, and at Eton, Murray County. The mineral is largely used as a substitute for white lead. It is used also in the manufacture of paper, rubber, oilcloths, paper collars and barium salts, as well as for refining sugar, glazing pottery and for enameling iron. Georgia last year produced about two-thirds of the barytes mined in the United States, all of which came from the Cartersville district.

Bauxite.—The first bauxite found in America was discovered near Hermitage, Floyd County, in 1887. Later, deposits were found in Polk, Bartow, Gordon, Chattooga and Walker Counties, and between 1907 and 1915 deposits were found in the vicinity of McIntyre, Wilkinson County, near Andersonville, Sumter County and also near Warm Springs, Meriwether County. Since 1888 a high percentage of the bauxite mined in this country has been obtained from Arkansas, Georgia and Alabama.

Chromite.—Only two counties in Georgia, namely, Towns and Troup, as far as known at present, have chromite in apparently commercial quantity. The deposit in Town County is located two miles due west of Hiawassee, on lot 92; while the deposit in Troup County is near Louise. From the latter locality a limited amount of ore has recently been shipped. The ore in both localities is associated with ferro-magnesian rock and is generally found in the form of boulders in residual clays.

Fullers Earth.—The best known deposits of fullers earth occur near Dry Branch, Twiggs County, and in the vicinity of Attapulgus, Decatur County, where they have been worked for some years. Extensive deposits also occur in Bibb, Columbia and other counties near the Fall Line. The deposits of Twiggs County are now being worked by the General Reduction Company. Georgia stands second in the production of fullers earth, being exceeded only by Florida.

HIGH-GRADE PAPER CLAY, MENAMEE KAOLIN COMPANY, BATH, AIKEN COUNTY, SOUTH CAROLINA

Graphite.—Both amorphous and crystalline varieties of this mineral occur in Georgia. The amorphous variety is quite abundant in the neighborhood of Emerson, Bartow County, where it has been mined on a more or less extensive scale. Fine samples of crystalline graphite have been found in Bartow, Pickens, Elbert, Hall, Madison, Douglas, Troup and

DRYING SHEDS, GEORGIA SEDIMENTARY KAOLIN MINE. HEPHZIBAH, RICHMOND COUNTY, GEORGIA

Cobb Counties. All of the graphite material so far mined in Georgia has been used as a filler for commercial fertilizers.

Iron Ores.—Iron ores occur in Georgia in large quantities. The most common ores are the brown ores, or limonites, and the fossil ores, or hematites. Magnetite also occurs. The brown iron ores are most abundant in Polk, Bartow and Floyd Counties, but workable deposits are also to be found in nearly every county in the northwestern part of the state. The ores associated with the Weisner quartzite sometimes occur in ill-defined veins, but more generally they are found in the form of pockets or irregular deposits in the residual clays. The brown iron ores of the Knox dolomite series occur chiefly in the form of pockets or irregular deposits in the residual clays. The deposits are quite variable in size. Some of the individual deposits in the vicinity of Cedartown have been worked on an extensive scale for more than ten years without exhausting the supply.

The red, or fossil, iron ores of Georgia are confined to Dade, Walker, Chattooga and Cataoosa Counties. These ores occur in the Red Mountain iron ore-bearing series, which is so well developed near Birmingham. These ores occur in contiuous beds varying from a few inches to several feet in thickness. Some idea may be had as to the abundance of the red fossil iron ores of Georgia when it is stated that the aggregate length of the outcroppings of the beds, which average more than two feet in thickness, is approximately 175 miles, and that in many places the ore can be economically mined to the depth of several hundred feet.

Manganese.—The manganese ores, like the brown iron ores, are confined chiefly to Bartow, Floyd and Polk Counties. The largest and most productive deposits are found in the vicinity of Cartersville, where the ores occur as irregular deposits in the residual clays derived from the Beaver limestone and the Weisner quartzite. The manganese deposits of Georgia have been worked almost continuously for many years. During their early workings the ores were shipped to England, but in the last few years they have found a ready market in this country, where they have been used in the manufacture of steel and for bleaching powder.

Mica.—Mica is widely distributed throughout the Piedmont Plateau. It has been worked to a limited extent in Upson, Cherokee, Lumpkin, Union, Hall and Rabun counties. Some of the most promising prospectsin Cherokee County are in the vicinity of Holly Springs and Toonigh, and in the Hickory Flats district about ten miles southeast of Canton. The Lumkin and Union County deposits, as so far developed, occur near the Lumpkin-Union county line. Upson County is now an active producer as well as Meriweather County. Mica has been mined in Rabun County at the Kell Mica Mine, 10 miles east of Clayton, and in Hall County, near Gainesville. In addition to these localities, good mica prospects are found in a large number of other counties in the Piedmont Plateau.

Ocher.—The ocher mines of Georgia produce more than one-half the yellow ocher output of the United States. These mines are located near Cartersville, Bartow County. The deposits are confined to a narrow belt about eight miles in length and less than two miles in width. The most extensive workings are those of the Georgia-Peruvian Ocher Company, situated on the left bank of the Etowah River, two and one-fourth miles east of Cartersville. Ocher mining in the Cartersville district had its beginning in 1887. In 1890, the Georgia-Peruvian Ocher Company began operations on an extensive scale, and later, three other large ocher plants were put in operation.

The total maximum output of these four plants is estimated at about 1,000 tons per annum.

The principal use made of the yellow ocher mined in Bartow County, up to the present time, is in the manufacture of lineoleums and oilcloths. The important markets are England and Scotland. It is also used to a limited extent in the manufacture of paints.

Potash-Bearing Slates.—Slates containing 7 to 10 per cent potash occur north of Cartersville, Bartow County, in a belt 15 miles long and 1 to 4 miles wide. The best exposures are near White, on the L. & N. Railway, where a thickness of several hundred feet of such material may be worked by open-cut methods. It is believed that these slates are exceptionally fine raw material for the extraction of potash for fertilizer and other purposes.

Pyrite.—This mineral occurs in commercial quantities in a number of counties. The most important deposits are in Lumpkin, Cherokee, Paulding, Cobb, Douglas, Harlson, Carrol, Towns, and Rabun counties. Mines operating in 1917 were the Chestatee mine, six miles northeast of Dahlonega, Lumpkin County; the

SOAPSTONE MILL AND STOCKYARD, OLD DOMINION CORPORATION, ALBEMARLE COUNTY, VIRGINIA

Standard mine near Creighton, Cherokee County; the Little Bob and Shirley mines near Hiram, Paulding County; the Marietta mine near Marietta, Cobb County; the Sulphur Mining & Railroad Company mine in Douglas County, and the Waldrop mine near Drake-town, Haralson County. Other promising deposits, which have been worked in the past or rather extensively explored are Reeds Mountain, near Bremen, Haralson County; the Southern Star mine, four miles west of Woodstock, Cherokee County; the Swift mine near Drakетown, Haralson County; the Swift or Blake mine at Creighton, Cherokee County; the Canton Copper mine, Cherokee County; and the Mammoth mine near Hiram, Paulding County. The copper ore from Mine No. 20, Fannin County, is also a source of sulphuric acid.

Sericite.—Sericite of exceptional purity occurs in Pickens County only a short distance west of Jasper, where it is found in beds from a few inches to six feet or more in thickness, interlaminated with quartz schist.

The mineral is a variety of mica made up of small elongated silver-colored shreds. It resembles talc very closely, in physical properties, and is often used for the same purposes.

The Pickens County sericite has recently attracted considerable attention as a raw material for the extraction of potash. Two different companies are now mining this material with a view of extracting the potash for fertilifier purposes.

Mineral Resources of Maryland

By Edward B. Mathews
State Geologist

Maryland is rather a center of supplies and refinement of mineral resources than a source of the raw materials. It was, however, the early finding of chromite, magnetite, copper, and iron in this region which led to the establishment of many of the larger industrial plants of Baltimore and vicinity. The presence of extensive deposits of serpentine carrying more or less chromite, the abundant distribution of pegmatite dikes with potash and soda spar, and the presence of extensive clay deposits including lenses of kaolin serve as the bases of industries in each of these mineral resources, and stimulate more or less prospecting for new or richer deposits. The large industries of coal, brick and tile, and cement are too well known to need further comment.

BLOCKS OF SOAPSTONE AS TAKEN FROM QUARRY—OLD DOMINION SOAPSTONE CORPORATION, ALBEMARLE COUNTY, VIRGINIA

MINING MANGANESE ORE WITH STEAM SHOVEL, NEAR FRONT ROYAL, VIRGINIA

Chromite has been the subject of renewed investigation and from prospects at one or two points small shipments may be expected. The bodies, however, are small and the tenor in available chrome generally 40 per cent or better. The material is found in place and also collected along stream bottoms.

Feldspar deposits have been prospected and there are a number of operations especially in the Pataspsco Valley in the neighborhood of Marriottsville and Woodstock and in Cecil County in the vicinity of Rock Springs. The material of the first area is potash spar, that of the second rich in soda. The smaller operations are feeling the lack of labor supply more perhaps than larger industries.

Clay has been one of the chief mineral products of Maryland since pre-Revolutionary time and the products have covered quite a range. At present, however, the industry is largely limited to the production of brick and tile and refractories with some enameled ware. Attempts at the present time are being made to develop blends consisting of Maryland and Tennessee clays to meet the shortage of German and English supplies.

North Carolina Minerals

By Joseph Hyde Pratt
State Geologist

Within the borders of North Carolina is found a wide variety of minerals, and, with the exception of perhaps one or two other states, a greater variety than in any other state in the Union. While most of these are of little or no economic importance, several of them are of large commercial value, and, of a few, North Carolina is the chief producing State. The principal mineral resources of the State, however, are building stones and clay products. Of the several minerals the following represent those of commercial importance that are now being produced in the state.

Metallic Minerals

Iron.—The principal iron ores of North Carolina are magnetite, hematite and limonite, the most valuable being the magnetites in Mitchell and Ashe counties, carrying from 31.16 to 68.34 per cent metallic iron.

These are exceptionally pure ores and make a very high grade of pig iron. The producing mines of limonite at the present time are in Madison and Cherokee counties. This ore is produced largely by open cuts. The most promising deposit of hematite is at Bessemer City, Gaston County, and ore was formerly mined and shipped to Birmingham, Alabama.

Copper.—The copper ores are composed principally of the sulphides and in the Blue Wing district of Person and Granville counties the ores are mostly chalcocite and bornite. In the Gold Hill district of Rowan, Stanly and Cabarrus counties, the ore is principally chalcopyrite. This is also true of the Cullowhee belt in Jackson county. In the Ashe County copper belt, which contains one of the most extensively developed mines in the State, the ore is composed of a mixture of chalcopyrite, pyrrhotite and some pyrite. Another belt in Swain and Graham counties is known as the Hazel Creek copper belt. At these two latter localities, considerable native copper has been found.

The mines of the Gold Hill district are auriferous pyrite and chalcopyrite with which is more or less gold-bearing quartz. The latter is the only gangue mineral of any importance. In the Cid mining district of Davidson County, the ores at the Silver Hill mine consist of a complex mixture of galena and sphalerite together with pyrite and chalcopyrite, the whole carrying silver and gold. At the Conrad Hill mine, the ores all consist of auriferous pyrite and chalcopyrite in a gangue of quartz, siderite, and hematite; and at the Emmons mine, the ores are auriferous pyrite and chalcopyrite in a quartzose gangue or as narrow stringers in the schists with little or no gangue.

Gold and Silver Ores.—The gold ores consist of free-milling and sulphide ores. The larger deposits of free-milling ore occur in what are known as slates and some of the difficulties encountered have been the separation of the very finely divided gold from the slates, which have some tendency to slime. In some of the mines the gold is rather coarse and little difficulty is experienced in saving it on plates. The lower portion of these deposits runs into the sulphides. The principal gold region of the State is that known as the "Carolina Gold Belt," extending across the central Piedmont region of the State running from the Virginia line in a southwesterly direction across Person, Orange, Guilford, Randolph, Davidson, Davie, Rowan, Montgomery, Stanly, Moore, Cabarrus, Mecklenburg, Catawba, Lincoln, Gaston, Cleveland, Union, Caldwell, Burke, McDowell, Rutherford, and Polk counties.

There is very little silver associated with the gold and the gold bullion is in a high state of fineness, running to 997. There is more or less silver associated with the copper ores of the State. There are but two silver mines known at the present time in North Carolina, the Silver Valley and the Silver Hill mines in Davidson County. The original ore in these mines is a mixed sulphide and in the upper portions of the vein where the sulphides have been decomposed, mining was carried on very extensively. When, however, the unaltered sulphides were reached, they were found to be composed of pyrite, chalcopyrite, galena and sphalerite, and on account of the complex character of the ore, it could not be profitably treated, and therefore mining operations were suspended. It is believed that now these complex ores can be separated and the ore bodies worked profitably.

Tin.—The most promising tin deposit in the eastern United States is near Lincolnton, Lincoln County, North Carolina. Casseritite, tin oxide, occurs in a decomposed pegmatite dike and, by working the deposit as a source of kaolin and saving the tin as a by-product, it is believed this property could be worked profitably. The tin ore occurs usually near the contact of the dike with the country rock and forms approximately ½ of one per cent of the contents of a width of 4 to 5 feet in the dike.

Chromite.—The principal chromite deposits are in Yancey County, and these are now close to railroad transportation. These deposits contain some of the highest grade chromite known, the Ray mine carrying ore running as high as 58 per cent chromic oxide per ton. Other promising deposits occur near Webster, Jackson County. These deposits are the most promising sources of supply of this mineral in eastern United States.

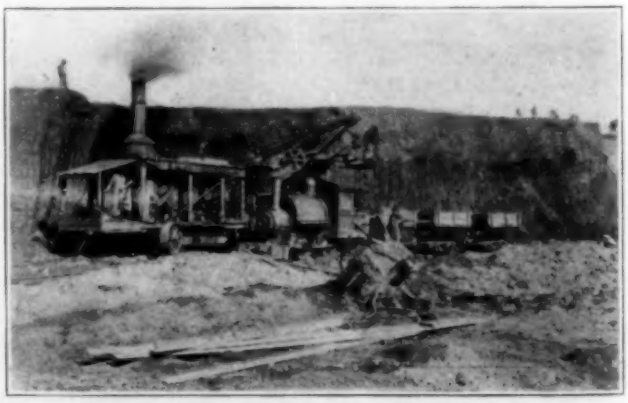
Manganese.—More or less manganese is found associated with many of the limonite iron ores. The most promising deposit is in Surry County where a property has recently been opened, but no quantity of ore has thus far been mined. An analysis of this ore gave 42.87 per cent of metallic manganese.

Non-Metallic Minerals

Corundum.—North Carolina was formerly the chief corundum-producing State in this country, but for several years very little of this mineral has been mined. The corundum deposits in Clay and Macon counties represent probably some of the largest deposits of crundum in this country. The corundum is of splendid quality.

Mica.—North Carolina mica has been known for years as "standard mica" and is considered the best grade of mica on the market. Many of the western counties contain mica in commercial quantity and its production has been constantly increasing for several years. It occurs in pegmatite dikes and is produced in the following counties: Mitchell, Macon, Jackson, Yancey, Haywood, Transylvania, Avery, Watauga, Ashe, Cleveland, Buncombe, McDowell and Stokes.

Monazite is found very extensively in the gravels of Cleveland, Rutherford, Burke, Polk, Lincoln, Catawba,



MINING BROWN IRON ORE WITH STEAM SHOVEL. RUSSELLVILLE, ALABAMA

McDowell, Gaston and Alexander counties. All the production is from placer mines. The gravels are washed and the concentrates cleaned magnetically so that the final monazite product contains approximately 95 per cent monazite. The most notable occurence of monazite in this country is near Mars Hill, Madison County, North Carolina, where in a pegmatite dike masses of nearly pure monazite were found weighing as much as 60 pounds.

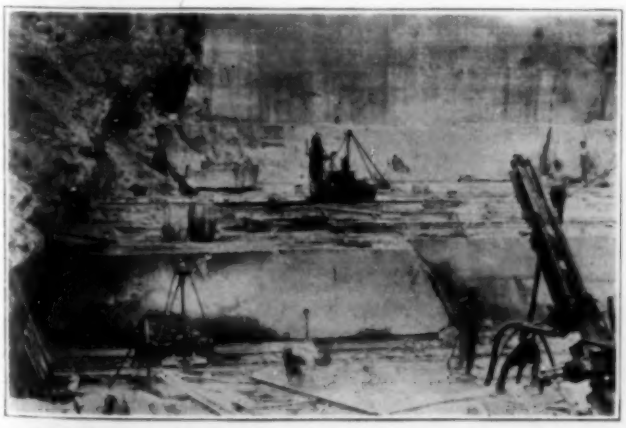
Zircon has been found in commercial quantity in Henderson County in one of the pegmatite dikes. The commercial demand is small, and for a good many years one property has been able to furnish the entire known demand for this mineral in this country, its use being in producing zirconia for use in the manufacture of the glower for the Nernst electric lamp. It also occurs in some quantity near New Sterling, Iredell County.

Barytes is being mined in Madison and Gaston counties. It is a hard, compact variety of very high grade. It is usually granular in structure, but occasionally masses of some size are obtained made up of cleavable blocks.

Talc.—There are several localities in North Carolina in which talc occurs in commercial quantity. The most noted locality is the Hewitt mine in Swain County which furnishes an exceptionally high grade of talc such as has not been produced at any other mine in this country. A splendid grade of talc also occurs in Cherokee County, and the soapstone variety occurs in Madison and Ashe counties. Pyrophyllite is mined in some quantity in Moore County and is used for some of the same purposes as talc. It has very similar physical but different chemical properties, it being a hydrous aluminum silicate.

Feldspar.—The potash variety of feldspar is now being mined in some quantity in Mitchell, Yancey and Watauga counties. The feldspar occurs in pegmatite dikes, usually in such form that it can be readily separated from the associated minerals. It is ground before being shipped.

Rare Minerals.—Several uranium minerals, such as uraninite, gummite, uranatil, and uranaphane are found in small quantity associated with some of the pegmatitic dikes of Yancey and Mitchell counties. The uraninite from the Flat Rock mine has the highest radio-activity of any uranium ore tested, according to Dr. B. B. Boltwood of Yale University. Several of the rare earth minerals have been found in some quantity in these pegmatitic dikes, such as samarskite, columbite, fergusonite, monazite, euxenite, hatchettolite, yadolinite, allanite and polycrose.



SOAPSTONE QUARRY SHOWING CHANNELING MACHINES —PHOENIX, NELSON COUNTY, VIRGINIA

Electrochemical Industries in Tennessee

By L. C. GLENN
Acting State Geologist

The electrochemical industry in Tennessee is in its infancy, just at present, but conditions for obtaining cheap electric power and abundant and varied supplies of raw materials are such that there are great possibilities for the development of these industries. It is the object of the present article to make a brief statement concerning present operations and indicate some of the most promising future possibilities.

Chlorine.—At Kingsport there has been noteworthy development of chemical industries of very varied type, and this is probably but a beginning of what the next few years will see at that place. Among these there is an electrolytic chlorine plant, and in connection with the Portland cement plant, potash is recovered as a by-product by the Cottrell process.

Aluminium.—At Maryville, near Knoxville, the aluminium plant consumes more electrical energy than any other one plant in the state. The raw materials for this plant come from Georgia, but deposits of bauxite are known at a number of places in Tennessee from near Chattanooga northeastward nearly to the Virginia line. There are developments of these deposits near Chattanooga and Elizabethton. The Maryville plant is planning for large hydroelectric development on the Little Tennessee River, and all indications are for a very great enlargement of their electrochemical work since when fully developed their series of dams will furnish about 400,000 horsepower.

Ferroalloys.—At Chattanooga a start has been made in the production of ferroalloys that gives much promise for future expansion. Aside from silica, which may be had in unlimited quantities for making ferrosilicon, there are pockety manganese deposits of high grade available in East Tennessee and the adjacent portion of Georgia for ferromanganese alloys, and in middle Tennessee there are large deposits of high-grade phosphate rock that would supply unlimited material for making phosphorus and ferrophosphorus. These latter substances are not as yet produced here electrochemically though a furnace in the phosphate field produces ferrophosphorus with coke as a fuel.

Undeveloped Possibilities.—Attractive possibilities for electrochemical experiment and development are furnished by the zinc ores of East Tennessee. These are now concentrated and shipped out of the state for reduction. With cheap power available and an abundance of ores, experiments in electrical smelting could be undertaken here under the most favorable circumstances. The manufacture of calcium carbide could be undertaken anywhere and abrasives could be made with equal ease. The iron ores of the region and industries dependent on iron and steel make it possible for both pig iron and steel to be produced by the electric furnace, and the demand for

BROWN IRON ORE WASHING PLANT, RUSSELLVILLE ALABAMA

such products must bring developments along these lines in the near future. Practically all of the raw materials now used in important electrochemical work are available either in the region or are accessible, as in the case of salt, in nearby regions.

Power and Labor Conditions, Etc.—Extensive development of hydroelectric power has already occurred in this region and there exist numerous other sites where large units may be developed at reasonable cost. Aside from such cheap hydroelectric power it is practicable to develop electric power very cheaply by steam in large plants located at any of the many coal mines in the Cumberland Mountain region of the state. Such plants would use slack coal delivered directly from the mine without railway haul, and could compete with hydroelectric power. The climate is favorable to continuous operation, and labor, under normal conditions, is abundant and cheap. Raw material of many other kinds is abundant and forms the basis for a varied industrial development in this region that must come in the near future.

Mineral Resources of Virginia in the Chemical Industries

By Thomas L. Watson

State Geologist and Professor of Geology, University of Virginia

Virginia produces annually more than thirty different mineral substances, the total value of which for the year 1916, the latest year for which completed statistics are available, including coke and pig iron, amounted to $30,407,414, proportioned as follows: Metallics, $2,088,492, nonmetallics, $18,154,007. The total value of coke and pig iron made in Virginia in 1916 was $10,164,915.

Among the metallics, the production includes ores of copper, gold and silver, lead and zinc, iron and manganese, and titanium; among the nonmetallics, asbestos, barite, cement, clay products, coal and its by-product coke, feldspar, gypsum, stone (granite, limestone, sandstone, and slate), lime, marl (greensand and calcareous), mica, millstones, mineral waters, pyrite and pyrrhotite, quartz, salt, sand and gravel, talc and soapstone, etc.

Some of these have been worked since early colonial days, especially coal, iron ores, and brick clays, while others are of more recent development, and all are capable of further greater expansion and production. Still others of scarcely less importance await development. Only a few of the more important raw mineral materials found in Virginia in commercial quantity and of value in the chemical and metallurgical industries can be mentioned in the space allotted.

Fuels.—The mineral fuel resources of Virginia are coal and its by-product coke, oil and gas not yet having been found in commercial quantity. The principal coal-producing territory of the State is in southwest Virginia and comprises approximately 1,550 square miles, including the whole or a part of Tazewell, Buchanan, Dickenson, Wise, Lee, Russell, and Scott counties. The coals are high grade bituminous and semi-bituminous varieties of established reputation for steaming and domestic purposes and for the manufacture of a superior grade of coke for various uses. Coals of excellent quality occur and are mined in other counties of western Virginia especially Montgomery and Pulaski.

An important coal area known as the Richmond coal basin, located in the eastern margin of the Piedmont province and covering parts of several counties, is the only area of free-burning coal in the eastern portion of the United States located immediately adjacent to Tidewater. The coals of this area were the first to be mined in the United States and they represent a good grade of the bituminous variety.

Limestone.—Inexhaustible supplies of calcareous materials admirably adapted to the various uses made of such materials, are readily available and extensively quarried over many parts of the State. These include the hard rock limestone and travertine (fresh water marl) of western Virginia, especially the Great Valley province, and more restricted areas of the former in the Piedmont province; and shell or calcareous marls of the Coastal Plain or Tidewater region. The limestones of the Great Valley region range in composition from calcium-magnesium carbonate to straight calcium carbonate, and are extensively quarried and utilized for all purposes made of limestone. Already many of the more important chemical industries of the State are partly based on the readily available inexhaustible supplies of this very necessary raw material.

Iron Ores.—The commercial deposits of iron ores in Virginia are confined to the Piedmont and Appalachian regions, and include the important types limonite or brown hematite, red hematite (specular

HIGH-GRADE FULLERS EARTH 20 FEET THICK, NEAR MACON, GEORGIA

and fossil), and magnetite. Of these, brown hematite is the most extensively mined and forms the principal source of the metal. The sulphides (pyrite and pyrrhotite) are mined on a large scale for acid making, and the iron residue ("blue billy") is utilized by the blast furnaces for making pig iron. Iron carbonates are found in several localities but thus far they have not proved to be an important source of the metal.

The brown iron ores of the Appalachian region, which include the "mountain," valley or limestone, and Oriskany ores, are commercially the most important ones in Virginia. The specular hematites of the Blue Ridge province are second in importance, the Clinton fossil ores third, and the remaining types are of minor importance.

The "mountain" brown ores extend along the west slope of the Blue Ridge, including the east side of the

BED OF PURE FINELY DIVIDED SILICA 50 FEET THICK, NEAR SHEFFIELD, ALABAMA

New River-Cripple Creek district. They range in iron content from 35 to 50 per cent, and in silica content from 10 to 30 per cent, with usually high manganese and phosphorus. The valley or limestone brown ores are distributed at intervals throughout the Valley province in association with the limestone residual clays. They are usually richer than the "mountain" ores, ranging in iron content from 40 to 55 per cent and in silica content from 5 to 20 per cent, with usually less than 1 per cent of manganese and enough phosphorus to be classed as a non-Bessemer ore. The Oriskany brown ores are the most important of the iron ores mined in Virginia. The principal producing district includes the counties of Alleghany, Botecourt, and Craig. They range between 35 and 50 per cent metallic iron, and are usually high in silica and manganese, resembling in this particular the "mountain" ores. The total number of blast furnaces in operation in the State is 14, several of which are making ferromanganese.

Manganese Ores.—Virginia has always ranked as one of the important manganese-producing states in the Union. The deposits extend over a wide territory in the Piedmont and Appalachian regions and include a large number of producing localities. Stimulated by the present war conditions the production of both high-grade manganese ores and manganiferous iron ores in the State has been recently greatly increased, and the deposits are capable of further greater production. New areas have contributed to the increased production. The ores are used both in the steel and chemical trade.

Acid-making Materials.—These include vast supplies of pyrite and pyrrhotite, which for many years have given Virginia the position of first producer of pyrite among the pyrite-producing states in the United States. The most important pyrite deposits are found in the Piedmont Plateau province, and have been and are still extensively worked in Louisa and Prince William counties, and to a less degree in several other counties, especially Stafford and Buckingham. The pyrite mines in Louisa and Prince William counties are probably the largest and most extensively developed ones in the United States.

The principal occurrence of pyrrhotite in the State is the "Great Gossan Lead" of Carroll, Floyd, and Grayson counties, which forms a well-defined vein of pyrrhotite up to 100 feet in width and traced continuously on the strike for a distance of more than 20 miles. It was formerly worked on the north end at Betty Baker, and has been mined on a large scale for the past fifteen years near Monarat, in Carroll County, by the General Chemical Company and treated in their plant at Pulaski for acid-making.

Besides pyrite and pyrrhotite, other sulphide ores mined in Virginia for purposes other than their sulphur, include the zinc blende deposits of the Valley region, especially those of Wythe County, the mixed sulphides, chiefly galena and sphalerite, of Albemarle, Louisa, and Spottsylvania counties in the Piedmont province, and the copper sulphides, chalcocite and bornite, of the Virgilina district, including Halifax and Charlotte counties, Virginia, and Person and Granville counties, North Carolina.

Salt and Gypsum.—Economically important deposits of salt and gypsum occur in southwest Virginia in the valley of the North Fork of Holston River in Washington and Smyth counties. These deposits have been extensively developed by two gypsum plants, one at Plasterco, the other at North Holston, and one alkali works of the Mathieson Alkali Company at Saltville, Smyth County, which is the center of the industry. The making of salt was stopped in 1903 and from that date to the present the salt brines have been utilized exclusively for the manufacture of alkali, chiefly sodium carbonate and caustic soda.

Barite.—This mineral has been mined for many years in various parts of the State. It occurs in many counties in the Piedmont and Appalachian regions, but the industry has been confined to only a few of them. The mineral is of excellent grade and entirely adapted to the various uses made of barite, especially in the manufacture of barium products. Many of the deposits capable of greatly increasing the present production remain practically undeveloped. The present principal mining operation is the old Hewitt mine located near Evington in Campbell County.

Rutile.—The largest and most important commercial deposits of rutile in the United States occur in the Roseland district, Nelson County, from which the entire production of the mineral in this country is derived from the mines of the American Rutile Company. Other deposits of this mineral of probable economic value are found in Goochland and Hanover

counties. The principal uses of titanium include metallic alloys, such as ferrotitanium and cuprotitanium, incandescent media for lighting purposes, mordants and dyes for leather and textiles, refractory coloring material for use in ceramics and the manufacture of artificial teeth, etc.

Miscellaneous Materials.—Under this heading are listed certain mineral materials which occur in Virginia that are no less important than those described above, but because of lack of space they cannot be discussed at present. Most of these have either produced or are producing, while others capable of producing have not been developed. These include tin (cassiterite), abrasives (emery, millstones, quartz, chert, and diatomaceous earth), mica, feldspar, asbestos, mineral paints, arsenic (arsenopyrite or mispickel), graphite, zircon, etc.

In conclusion it may be stated that Virginia's enormous supplies of high grade coal, limestones, and ores of various kinds, coupled with her abundant water resources, favorable and healthful climate, and excellent railroad facilities, afford almost unparalleled opportunity for the production and manufacture of a great variety of chemical and metallurgical products.

The Mineral Resources of West Virginia Available for Chemical, Metallurgical, and Electro-Metallurgical Manufacturing

By I. C. White

State Geologist

West Virginia possesses none of the precious metals in commercial quantity. However, dame Nature has endowed this State with such an infinite wealth of the common and more useful substances that her mineral wealth probably exceeds in value any equal area in any other political division of the continent. In fuel wealth of coal, petroleum, and natural gas she stands without a rival. With a greater variety of coal than Pennsylvania, she comes next to her in production, and within less than a decade bids fair to surpass even Pennsylvania in the output of bituminous coal. Her petroleum is of the highest grade produced anywhere in the world and although the industry began nearly 60 years ago her oil and gas wells still yield 8 to 9 million barrels of white-sand oil annually along with over 300 billion cubic feet of natural gas, practically two-fifths of all the latter product that is marketed in the entire United States, while the casing-head gasoline, and carbon black production (this last industry having originated in West Virginia) are of very great extent.

In the variety of bituminous coals, West Virginia stands unique—Steam, Domestic, Gas, Coking, High Volatile, Low Volatile or Smokeless, Splint, "Block," Cannel, oil shales being available in the several districts of the Commonwealth.

Location of the Several Varieties of Coal

The celebrated Pittsburgh coal bed, probably the most valuable single fuel deposit in the world, ideal for steam and general fuel, unexcelled for gas and coke (being the same bed as the one which furnishes the Connellsville coke for Pittsburgh's great iron and steel industries), underlies approximately 1,300,000 acres, largely in the northern half of the state. Under the principal portion of this vast area, this coal would average a recoverable thickness of six feet, or say 10,000 net tons to the acre, thus totaling 10 billion tons of commercial coal for this one seam.

This Pittsburgh coal is very rich in by-products as may be judged from the following average composition of the coal at 51 mines in the counties of Monongalia, Marion, Harrison, Taylor, and Barbour Counties, as determined by Mr. Frank Haas, Consulting Engineer and Chemist for the Consolidation Coal Company:

	Per Cent.
Moisture	1.43
Volatile matter	37.47
Fixed carbon	53.83
Ash	7.27
Total	100.00
Sulphur	2.59
B.t.u., per pound	14,014

A ton of Pittsburgh coal from the mines now owned by the Jamison Coal and Coke Company at Underwood, Marion County, West Virginia, and tested by the New England Gas and Coke Company, of Boston, Mass., gave the following by-products:

Ammonia	22 pounds
Coal tar	10 gallons
Surplus by-product gas	6,000 cubic feet
Coke	1,600 pounds

In addition to this great Pittsburgh seam in the northern half of West Virginia are two other principal coal beds; viz, the Upper Freeport Coal, 600 feet below the Pittsburgh bed, and the Lower Kittanning, the latter coming 175 to 200 feet lower. In the northern Panhandle, or Ohio, Brooke, and Hancock Counties, as also northern Wetzel, there is also a large area underlain by the Lower Freeport Coal, 50 feet below the Upper Freeport bed. This bed is 4 to 6 feet in thickness, and makes an excellent coke either in beehive or by-product ovens. It will form a great reserve of coal for the Wheeling and Ohio Valley manufacturing industries for many miles southward long after the great Pittsburgh seam lying 600 feet higher has been exhausted.

The Upper Freeport Coal of Monongalia, Preston, and adjoining counties makes an excellent coke, and is especially valuable for mixing with low-volatile coals for coking in by-product ovens, since this coal contracts in passing into coke, while some other coals swell up and thus tend to disrupt the expensive ovens. The average analysis of 1500 samples of this Upper Freeport Coal from Preston and Monongalia Counties gave the following results:

	Per Cent.
Moisture	1.60
Volatile matter	27.80
Fixed carbon	63.04
Ash	7.56
Total	100.00
Sulphur	0.99

The average analyses of 925 samples of coke from the same region gave the following:

	Per Cent.
Moisture	0.80
Fixed carbon	86.54
Ash	12.66
Total	100.00
Sulphur	0.98

A by-product test on a car-load of this coal, made at Indianapolis, Indiana, by the Citizens Gas Company of

that city, in March, 1912, yielded the following results:

	Pounds
Weight of dry coal charged	14,460
Dry coke produced, large pieces. 74.35 per cent	10,752
Dry coke produced, small pieces. 0.93 per cent	135
Breeze produced. 1.58 per cent	229
Total. 76.86 per cent	11,116
Yield of tar, 4.36 per cent. of dry coal	630½
Sulphate of ammonium, 1.21 per cent. of dry coal	173

The splendid quality and wonderful variety of coals in the southwestern half of West Virginia along the lines of the Coal and Coke Railway, the Kanawha and Michigan, Chesapeake and Ohio, Virginian, and Norfolk and Western Railways, are so well known in the markets of the country that they scarcely need any special description. These coals are described in detail and published along with hundreds of analyses in the reports and maps of the West Virginia Geological Survey, a list of which briefly describing each publication can be obtained from the offices of the Survey, Morgantown, West Virginia.

Some of these "Kanawha Splint" coals, like the Coalburg and Winifrede, contain such a small quantity of iron in the ash that the latter is practically white and hence these coals can be used to great advantage as a fuel in the manufacture of snow-white Portland cement. The fusing point of their ash is above 3000° F.

The New River and Pocahontas Coals are generally known to the trade as "smokeless" and are specially valuable for steam and bunkering purposes for use on freight and battle-ships, and they make splendid coke.

The total coal deposits of the several counties of the State as figured from the detailed surveys of the several counties already made and from close estimates on the few (7) remaining ones not reported upon aggreate a net tonnage of 105 billion, of which at least 83 billion net tons may be regarded as recoverable coal. The total quantity of coal already mined during the 60-odd years of West Virginia's coal mining history totals only about one billion net tons, or less than 1 per cent of her total deposits. Hence the West Virginia factories and those to be located therein hereafter can be assured of a practically unlimited and cheap fuel supply extending into a far distant future.

Limestone in large deposits of commercial value is confined to the eastern counties of the State, like Jefferson, Berkeley, Morgan, Hampshire, Mineral, Hardy, Pendleton, Pocahontas, Greenbrier, Monroe, and Mercer, although thick deposits occur in Monongalia, Preston, Tucker, Grant, Randolph, and Barbour, belonging to the Mountain or Greenbrier Group. Up to this time the only large quarry operations on the limestones of the State, except for railway ballast and one cement factory at Manheim in Preston County, are located in Jefferson and Berkeley Counties, where vast quantities of the very highest grade of limestone used in the manufacture of plastering lime, hydrated lime, Portland cement, and for flux in iron and glass furnaces, crop out along the Baltimore and Ohio, Norfolk and Western, and Western Maryland, and other railway lines. These limestones are fully described and analyses given in the Survey volume on Jefferson, Berkeley, and Morgan Counties, along with the other minerals of that area including vast deposits of very pure Dolomite.

Iron Ores, of which West Virginia has 200 to 300 million tons, principally in the counties of Hampshire, Hardy, Mineral, Grant, Pendleton, Pocahontas, Greenbrier, and Monroe, are described in Volume IV of the West Virginia Geological Survey, along with the enormous resources of the State in glass-sand, and saline brines, many analyses of all of which are given therein.

Saline Brines along the Ohio River Valley to be obtained by boring to depths of 1000 to 1200 feet anywhere between Moundsville and Kenova, and along any of the tributaries of the Ohio, like the Little Kanawha, Great Kanawha, Guyandot, Twelvepole, and Big Sandy Rivers, are especially rich in other minerals besides common salt; viz., bromine, and calcium and magnesium chlorides, etc. These brines have been operated continuously in Kanawha County for more than 100 years, and for nearly that long in Mason County on the Ohio River, and as a basis for large chemical industries where good coal exists in the immediate hills, or else can be brought by cheap rail or waterborne freights to the immediate doors of the factories, no more attractive sites could be found in the entire country. The composition of these brines is shown by the following analyses reproduced from Volume IV, West Virginia Geological Survey, page 332:

	Parts in 1,000 Parts by Weight
Sodium chloride	60.1762
Sodium bromide	0.2238
Sodium iodide	0.00098
Sodium nitrate	0.00000
Sodium arsenite	0.0000097
Sodium borate	Small amount, not estimated
Potassium chloride	0.5700
Lithium chloride	0.1010
Ammonium chloride	0.0787
Barium chloride (= 46.14 grains per gallon)	0.7447
Strontium chloride	0.2013
Calcium chloride	15.0103
Magnesium chloride	4.9692
Calcium bicarbonate	0.2661
Ferrous bicarbonate	0.0822
Manganous bicarbonate	0.0076
Calcium phosphate	0.0005
Aluminum	Trace
Silica	0.0040
	83.3456
Specific gravity at 15.5° C. =	1.0628

The Clay industry of West Virginia is only in its infancy, having been confined principally to the counties of Ohio, Brooke, and Hancock, along the Ohio River front, where are situated some very large sewer-pipe, brick, china, pottery, and other clay-working industries. Good clays and shales for the manufacture of common, vitrified, and pressed brick, however, are abundant in nearly every county of the State, and large clay-working industries are possible in the immediate vicinity of good gas territory, and outcropping coal beds. The succesful potteries at Cameron, Mannington, etc., and the vitrified products made at Parkersburg, Huntington, Weston, and elsewhere in West Virginia, as well as the large and successful brick plants at Charleston, Huntington, Thornton, Hammond, Morgantown, and elsewhere in the State, demonstrate the wide field open for these and kindred investments where the raw materials, like glass-sands, limestones, iron ores, clays, saline brines, etc., are in close physical association with vast deposits of coal and natural gas.

Some Experiments on the Extraction of Radium from American Pitchblende Ores by Chlorination

By Mrs. RAY CABLE and HERMAN SCHLUNDT

THE uraninite in the pitchblende ores of Gilpin County, Colorado, occurs very intimately associated with iron pyrites. Apparently no satisfactory method of separating the uranium minerals from the pyrites by mechanical methods has been developed. Concentration of the ore by the ordinary mill operations results in several products ranging in content of uranium oxide, U_3O_8, from 1 per cent to 25 per cent. The final blending gives three grades: high-grade, containing upwards of 16 per cent U_3O_8; medium-grade, averaging about 4 per cent; and low-grade containing less than 2 per cent U_3O_8. The main body of all grades however is iron pyrites.

The extraction of radium from these ores has been carried out successfully on a commercial scale by methods developed in the U. S. Bureau of Mines. During the summer of 1916 one of us assisted for a time in the laboratory experiments conducted in the Mining Experiment Station of the U. S. Bureau of Mines at Golden, Col., preliminary to plant operations. We were thus brought face to face with some new problems in radium extraction from an ore differing fundamentally from the European pitchblendes in its distinctively high content of sulphide minerals. Subsequently we continued our investigations on these ores in the chemical laboratory of the University of Missouri. The experimental results here presented summarize the results obtained by a new method of extracting radium by direct chlorination of the ore. We are indebted to Dr. R. B. Moore, Superintendent of the Golden Station for the samples of ore used in these experiments.

The Reaction

When the ore is heated in an atmosphere of chlorine, interaction takes place readily. The principal products of the reaction are sulphur monochloride, S_2Cl_2, and chlorides of the metals present. The reaction of chlorine with iron pyrites takes place mainly according to the equation,

$$2FeS_2 + 5Cl_2 = 2FeCl_3 + 2S_2Cl_2$$

and is an example of one of the general methods of preparing sulphur monochloride. By conducting the reaction in a stream of chlorine gas the chloride of iron together with chlorides of uranium appear as a crystalline deposit in the cooler parts of the apparatus, while the more volatile product, sulphur monochloride, can be separated as a gas which is easily condensed and collected in a receiver. Chlorination probably converts the radium into chloride, which, contrary to our expectations, is also carried forward in the current of chlorides, a relatively small fraction only remaining with the unattacked constituents of the ore.

Upon the addition of water to the residue and anhydrous chlorides of the metal a very vigorous interaction occurs. The radium compounds for the most part remain in solution. After filtering off the small insoluble residue, the radium can be precipitated very nearly quantitatively as radium-barium sulphates by adding to the filtrate a little barium chloride solution and its equivalent of sulphuric acid. The addition of sulphate ions to precipitate the radium-barium sulphates is, as a rule, not necessary inasmuch as a small quantity of sulphates is generally produced in the course of the chlorination. The reason for the radium not precipitating in the presence of sulphates when the chlorides are treated with water, we are inclined to attribute to the lack of sufficient barium in the ore. Recent determinations of the solubility of pure radium sulphate conducted by Lind, Underwood, and Whittemore[1] in the Golden Station of the U. S. Bureau of Mines have fixed the solubility of radium sulphate in water as approximately a hundredfold less than that of barium sulphate. Nevertheless the minute quantities of radium in the solutions here under consideration still lie below the solubility product of radium sulphate. However when radium sulphate is precipitated together with a large excess of barium sulphate the solubility of radium sulphate is far below the actual solubility of radium sulphate. Hence precipitation of barium sulphate in quantity a hundredfold or more the solubility of barium sulphate in the solution results also in a practically quantitative precipitation of the radium.

The Ore Samples

Experiments were conducted with the three grades of ore designated respectively low, medium, and high-grade. The radium content of each grade was determined quantitatively by separating the emanation from weighed samples, and measuring the ionization current product by it in standardized electroscopes[2]. The percentage of uranium was computed by multiplying its radium content by the established constant, 3×10^6, for the ratio of uranium to radium in primary uranium minerals. The analytical results thus obtained appear in the tabulated summary given herewith. The percentage of uranium in the high-grade ore was also determined by chemical analysis in the laboratory of the Bureau of Mines and found to be 17.58 per cent U_3O_8, a value in close agreement with the uranium oxide equivalent of 17.45 per cent calculated from the radium content. Since some emanation is continuously liberated from the ore under ordinary conditions of temperature and pressure it is necessary in making radium determinations on samples not previously sealed until equilibrium has been

[1] Jour. Amer. Chem. Soc., XL. 3, March, 1918

[2] For a description of the method and the apparatus used see, Lind, "Practical Methods for the Determination of Radium." Jour. Ind. and Eng. Chem. 7, 406 and 1024 (1915). See also Schlundt and Moore, Jour. Phys. Chem. 9, 320, (1905)

attained to determine the emanating power on another sample. We found that the emanation lost in the cold ranged from 6 to 9 per cent of the total in the different grades. The values for the radium content given in the table are, of course, based upon the equilibrium quantity of emanation.

In making the radium determinations the emanation was separated by dissolving suitable quantities of the finely ground ore in 40-per cent nitric acid and collecting the gaseous products in a gas burette over a hot solution of sodium hydroxide. The interaction of hot nitric acid with the sulphides of the ore produces several oxides of nitrogen, one of which, nitric oxide, is absorbed only very sparingly by the alkaline solution. As a result the volume of gas in determinations where samples of about a gram of ore were required was found to exceed the capacity of our gas burettes. This difficulty in the usual procedure may be overcome either by largely displacing the air in the reaction flask with oxygen before introducing the nitric acid, or by admitting oxygen into the burette from time to time during the progress of the reaction. Oxygen converts nitric oxide into nitrogen peroxide, NO_2, which is readily absorbed in the solution of lye.

The Experiments

For chlorination, the ore in charges of 30 to 35 grams was spread out over about one-third the length of a 1½-meter piece of hard-glass combustion-tubing of fully 2 cm. diameter, fitted at both ends with one-hole rubber stoppers. The ore charge was heated in a long combustion furnace of the type usually employed for combustion analysis of organic compounds. On the one hand the tube was connected with a tank of liquid chlorine, and on the other with a condenser and receiver. A wash-bottle containing sulphuric acid was placed in the train next to the chlorine tank, and this was followed by a T-tube dipping into mercury which served as a vent for the escape of chlorine in case the products of the reaction ever clogged up the outlet end of the tube. A plug of glass wool was inserted near the outlet end of the tube to stop small amounts of metallic chlorides that are apt to be swept along by the vapors of sulphur monochloride when chlorination is rapid. In the early experiments the ore charge was placed in several porcelain boats, but after finding that only a small fraction of the radium remained with the unattacked residue the boats were no longer used.

The chlorination was conducted by heating moderately at first with a slow stream of chlorine passing until rapid reaction starts which occurs before low redness is reached. The supply of chlorine was then materially increased and the temperature gradually raised to low redness. The metallic chlorides formed are deposited along the tube beyond the heated portion and sulphur monochloride passes on to the condenser if the cooler part of the tube is kept at a temperature above 137°, the boiling point of the monochloride.

Chlorination of the low-grade ore was at first carried out with samples ground to pass through an 80-mesh sieve, but when it was found that this degree of comminution is not necessary for complete chlorination, ore of 20-mesh was used in the subsequent experiments with medium and high-grade ores. Several of the chlorinations lasted three to five hours but in most of the experiments the flow of chlorine was so regulated that a charge of 35 grams was completely chlorinated within an hour. Turning the tube a little with an occasional tapping saves time.

When the tube had cooled it was taken from the furnace and the contents washed out with water or very dilute hydrochloric acid. After boiling, the insoluble residue, the tailing was filtered off, washed, ignited and weighed. The filtrates were again heated to boiling and radium precipitated by adding a few cc. of a 10 per cent solution of barium chloride and an excess of sulphuric acid. Three or four days after precipitation the sulphates were filtered off, ignited, weighed, and finally assayed for radium. The liquors were diluted to 500 cc. and samples of 200 cc. were boiled and sealed up for quantitative determinations of radium remaining in solution.

Complete duplicate experiments were conducted with each grade of ore. The recovery of radium in the sulphates, and the losses of radium in the tailings and liquors were determined by the emanation method. Carefully standardized electroscopes[3] of the interchangeable type[4] designed by Dr. Lind of the Bureau of Mines were used in the radium determinations, and use was made of the apparatus for boiling off and transferring the emanation described by the same author. Small samples (20 mg.) of the radium bearing sulphates were fused with mixed carbonates of sodium and potassium in small platinum boats which were then stored in sealed tubes for definite periods and finally decomposed with 1:1 nitric acid in an apparatus for collecting the emanation quantitatively. For determinations of radium in the tailing samples, about half the quantity of insoluble residue from 35 grams of ore was fused with mixed carbonates in platinum crucibles, the melt poured out into an iron mortar, powdered and then sealed in thin glass bulbs. After several days of storage the accumulated emanation was separated by decomposition with nitric acid. Details of the procedure and calculation of the results are given in some of the references cited.

The Results

The experimental results are summarized in the Table I.

The recovery of radium is satisfactory for each grade of ore, and the radium content of the sulphates lies well within the limit required for further concentration by fractional crystallization after conversion of the sulphates into chlorides. The concentration ratios were computed by dividing the figure for the concentration of radium in the sulphates by the radium content of the grade of ore from which the sulphates were recovered. The radium losses given for the liquors are probably too low inasmuch as our method of testing simply accounts for the radium actually in solution, and does not include possible traces of radium carried in suspension. We are, therefore, inclined to assign the percentages of radium unaccounted for at least in large part to this avenue of loss because a second

[3]Learning, Schlundt, and Underwood, Trans. Am. Electrochem Soc., 30, 375, (1916)

[4]Loc. Cit.

precipitation of barium sulphate in the liquors invariably gave a "second" sulphate of higher radium content than the loss found in the liquors by our method of testing. We are convinced that the loss of radium in the sulphur monochloride is negligible. In one experiment the residue left upon evaporation of the chloride when tested by the ordinary alpha-ray method showed no activity whatever.

It would be interesting to ascertain whether the radium in the deposit of metallic chlorides can be further concentrated by volatilizing the anhydrous chlorides again. Perhaps the radium would then remain for the most part in the non-volatile residue.

We hope to extend the investigations in the near future to larger samples of ore.

A few chlorination experiments with carnotite ore did not give results of promise for a method of extracting radium.

The chlorination experiments with low-grade ore represent one phase of a more extended investigation on the extraction of radium from pitchblende ores to be submitted by Mrs. J. Ray Cable as a thesis in partial fulfillment of the requirements for the degree of Master of Arts, University of Missouri.

Chemical Laboratory, University of Missouri

TABLE I. SUMMARY OF RESULTS

	Grade of Ore	Low	Medium	High
2	Radium content of ore, parts per billion	3.43	8.312	49.27
3	Uranium content of ore, expressed as U_3O_8	1.20%	2.92%	17.45%
4	Weight of ore used	32.0 g.	35.0 g.	35.0 g.
5	Weight of tailings	3.30 g. = 10.32%	0.795 g. = 2.27%	3.53 g. = 10.09%
6	Total radium in ore sample	109.8×10^{-9} g.	290.9×10^{-9} g.	$1,724.5 \times 10^{-9}$ g.
7	Weight of sulphates recovered	0.0938 g.	0.237 g.	0.635 g.
8	Radium recovered in sulphates	102.5×10^{-9} g.	267.1×10^{-9} g.	$1,615 \times 10^{-9}$
9	Radium recovered in sulphates	93.34%	91.78%	93.68%
10	Concentration of radium in sulphates—parts per billion	1,084	1,127	2,543
11	Concentration ratio	316:1	135:1	51.6:1
12	Radium losses:			
	(a) In tailings—emanation method	1.954×10^{-9} g. = 1.74%	4.36×10^{-9} g. = 1.53%	56.6×10^{-9} g. = 3.29%
	(b) In liquors—emanation method	4.23×10^{-10} g. = 0.34%	1.49×10^{-9} g. = 0.51%	4.43×10^{-9} g. = 0.26%
13	Radium unaccounted for	4.58%	6.18%	2.77%

Hydro-Electric Power in Relation to Industry*

By J. A. JOHNSON

THIS country is undoubtedly on the eve of a great development of its hydro-electric power resources. If it isn't, it ought to be. The time is ripe for it and conditions demand it. The nation is facing the gravest crisis in its history, not only in a military sense but in a political and economic sense. Our immediate problem of course is to win the war, but after the war is over there will be other problems to solve. Labor, for instance, has undoubtedly got to be reckoned with, and there will be immense problems involving the control of industry by the government and the attitude and spirit in which that control is to be exercised. Are we to go in for government ownership and operation of industry, or are we not? And if so, to what extent and how?

These and many other questions are demanding answers, and it therefore seemed to me that it would be far more profitable and useful for us to discuss this phase of the problem, than merely to be listening to a more or less instructive address on power-plant design. I therefore concluded that I would try to discuss the subject from the standpoint of the utilization of the power, that is, the relation of hydro-electric power to industry.

Essential Factors in Industry

In any industrial or manufacturing undertaking there would seem to be about five major factors which largely determine its location and its success or failure after it is located. These are—

1.—Raw material
2.—Transportation
3.—Power
4.—Labor
5.—Market

Raw Materials must be transported to the plant, then transformed by means of power and labor into the finished product and again transported to the market. We are to consider the relation of the factor of power, principally hydro-electric power, to the other four, raw materials, transportation, labor and market.

Industries may be broadly divided into two general classes:

1.—Those in which the cost of power is a large part of the cost of the product.
2.—Those in which the cost of power represents only a small percentage of the cost of the product.

Power developments may also be broadly divided into two general classes:

1.—Those having a continuous steady supply of water, such as Niagara Falls, and which are therefore capable of delivering power continuously;—and
2.—Those having a more or less variable supply of water, and which are therefore incapable of supplying continuous power.

In the first class of industries are those using electric power in large quantities for electrochemical and electrometallurgical processes. In such industries a low power-cost is usually essential to meet competition in the finished product from other more favorable sources. Such industries usually work with continuous processes, or at least processes requiring continuity for highest efficiency, consequently require power continuously, and therefore necessarily seek power sources of the first class, which can continuously supply the power continuously needed.

In the second class are those industries using power for mechanical purposes, that is, for driving machinery. Such industries usually operate for eight to ten hours per day only, hence have a low load factor, that is, they require their power only intermittently. Such industries therefore are adapted to utilize hydro-electric power sources of the second class, which have an inherently low "supply factor," as it might be called.

Now, this country is going ahead and developing its

*A paper read before *The Engineering Society of Buffalo* on March 13th, 1918.

hydro-electric powers. What is it going to do with them after they are developed? How are they going to be used? Are continuous powers to be frittered away and wasted in losses in long transmission lines and in supplying the intermittent demands of intermittent industries, while perhaps continuous industries are left to operate inefficiently on the "leavings" in the form of intermittent powers and the intermittent off-peak or secondary capacity of the continuous developments which have been primarily used for intermittent service? Or, is an intelligent effort going to be made so to co-ordinate the requirements of industry with the characteristics of the power developments that each development will be utilized in the most efficient manner?

If the problem were as simple as it sounds, it would be a fairly easy matter, but unfortunately or otherwise, it is not so simple. Hydro-electric developments are extremely diverse in character. They range all the way from plants having a "supply factor" of 100%, i. e. capable of delivering their full output continuously to those whose "supply factor" is perhaps no greater than 10% or even less. Furthermore, the time factor enters into the problem. Some plants, having practically no storage, and located on variable streams, are obliged to deliver their power practically as the water flows. They are, therefore, subject to great seasonal variations, and other irregularities of flow, which place a limit upon the extent to which they can be developed economically. In order to utilize such developments to the best advantage, they have to be supplemented by some other source of power, such as steam plants, in order that the industries using power may be assured of a reasonably constant power supply throughout the year. In cases where the cost of development is not too great, this plan is feasible and is often employed.

Other plants there are, which can be developed with a small amount of water storage capacity. Such plants can utilize a slightly larger proportion of the total flow and can themselves take care of load fluctuations of short duration, such as the demands of eight to ten hour customers, through their ability to store up water during the night for use during the day. There are already hundreds, perhaps thousands of such powers developed, often for the driving direct by water wheel of small manufacturing plants. Many a small town is built up around just such a power. There are doubtless thousands of others, many of them in inaccessible locations, which might be developed and the power transmitted to the nearest towns there to be used for similar purposes. Such powers can probably best be developed in connection with larger developments in their neighborhoods, and probably will be developed to a greater and greater extent through the application of the automatic generating station which has now been brought out by one of the largest electric manufacturing companies. This, by the way, is an extremely interesting innovation. Such stations require no attendance except periodically, and are cut on and off the circuit automatically through the agency of automatic switches operated by the water level in the forebay. In my opinion such stations are destined to play an important part in the development and utilization of our small water powers, of which we have a vast number, aggregating a very large amount of power.

Still other powers can be provided with vast storage reservoirs capable of storing up a large proportion of the total flow of the stream for months at a time, thereby enabling the power plant to operate nearly or quite continuously throughout the year. Sometimes a whole river can be so controlled and regulated by means of large reservoirs at the head waters which can be created by storage dams, thereby enabling a whole series of power plants located at different points on the river to be operated continuously, all using the same water as it flows down toward the sea. In this way the enormous quantities of water liberated by the melting snows of spring can be stored for use during the dry summer months and the fall rains for use during the frozen winter months.

Cost of Developing Hydro-Electric Power

Water powers also vary greatly as to their costs per horsepower developed. Nothing is more false than the popular belief that water power is necessarily cheap because water is a free gift of nature.

The cost of developing a hydro-electric power proposition may be anywhere from about $40.00 to $200.00 per horsepower. Developments costing less than this minimum are few and far between, and above about this maximum they cease to be commercially practicable under present conditions.

Hydro-electric developments also vary greatly in location. Some are located in the midst of densely populated districts, others more distant from civilization, and still others far away in the inaccessible wilderness. Victoria Falls, South Africa, one of the largest if not the largest single possible source of power in the world, is located so far from all human activity that it has thus far been impracticable to develop it. On the other hand, our own Niagara, located though it is in the very midst of the most thickly populated portion of the United States and Canada, is as yet only developed to a fraction of its possible capacity. In fact, water powers vary greatly in location with respect to all four of the factors of industry, raw material, transportation, labor and market.

It is clear then that hydro-electric powers are of infinite variety as to characteristics, cost and location. The problem therefore of co-relating industries with hydro-electric power is a complicated one.

Nevertheless, if our natural resources are to be conserved to the greatest extent, it is necessary, not only that our water powers shall be developed and put to work, but also that each power shall be put at the work it is best suited to perform. This applies not only to water power, but to steam power as well. It is an economic waste to use low-cost power for purposes for which higher-cost power would serve equally as well in those cases where the cost of the product would not be materially increased thereby.

It would seem worth while, therefore, to inquire to what uses the several types of hydro-electric developments should be put for the greatest economic benefit. Let us then consider briefly the several types of hydro-electric powers as related to industrial use.

Types of Hydro-Electric Development

First, consider a power located in the wilderness at a considerable distance from all four of the factors of industry. How is it to be utilized? Obviously only in

exceptional cases can the industry go to such a power, the exceptions being when some one or more of these factors can conveniently and cheaply be brought to the power along with the industry. In most cases such a power can only be utilized at all by transmitting it to the neighborhood of a sufficient number of the industrial factors to enable it to be utilized economically. Such transmission costs money, introduces power losses and adds to the cost of the power, and the power so transmitted must be able to compete with power from other sources such as coal, gas or oil. Power which has been transmitted any great distance is usually too greatly increased in cost thereby for use by the continuous class of industries mentioned, hence a market for it must be found among public utilities and industries of the intermittent class to whom the cost of power is not of vital moment.

As an example of a power of this general character I would mention the Salmon River Power Co. Such powers are often unsuited to the use of industries of the continuous class not only on account of cost, but also owing to their inherently low "supply factor" characteristic. The Salmon River Co. is such a one, as it is upon a stream of very variable flow, and could be developed at all only by resort to storage. This plant is located about forty miles north of Syracuse, near the little town of Altmar, N. Y., and as you doubtless all know, is now a part of the system of the Niagara, Lockport & Ontario Power Co., supplying a general industrial and public utility load, a service to which it is eminently well suited, and about the only type of industry which is suited to it.

There are many such powers yet undeveloped, for the reason that they are so far from civilization that they cannot compete in the market with power from coal, but it is quite possible to conceive that government control may, by regulation of the uses to which coal and other consumable resources may be put, force the development of such powers for use by public service and manufacturing industries to which the cost will not constitute an excessive burden if the competition of coal is eliminated. The development of such powers would, in the natural course of events, await the increase in the price of coal, but if the government fixes arbitrarily the price of coal, it may also determine to what uses it may be put, under which conditions inaccessible powers could and should be developed. The coal would thereby be conserved for those uses for which electric power is too costly.

In view of the present situation it does not seem at all improbable that such a situation may come about in the not far distant future.

Now let us consider the power which is located near one or more of the four factors of industry. Such powers may be and are of infinite variety as to their size and characteristics, and also as to the particular factor or factors to which they are accessible.

Take for instance the Shawinigan Water & Power Company at Shawinigan Falls, Quebec. Located about midway between Montreal and Quebec City, on the end of a branch of the "Great Northern Railway," it had, at the time of its first development, neither raw material, transportation, nor nearby market. Montreal and Quebec would appear to offer the best outlets for the power, and transmission lines were built to the former, but the location, only about twenty miles from the St. Lawrence River, and the abundant supply of cheap labor from the French Canadian population, soon overcame the apparent drawbacks, and large electrochemical industries proceeded to locate close to the development. Railroads were built to the St. Lawrence at Three Rivers, thus supplying the two factors of cheap transportation and labor, which, coupled with cheap power, were sufficient to overcome the lack of raw materials and a nearby market. Shawinigan Falls is now a thriving industrial city, and the power of the St. Maurice River is being used at the source in the manufacture of the manifold electrochemical products which have become so essential to modern civilization.

Consider also Niagara Falls. Here is a power almost unlimited in quantity, absolutely continuous in character, fairly cheap to produce, with abundant transportation and labor immediately at hand, and practically in the midst of the market for its products. How should that power be used in order to produce the greatest benefit to the nation and to mankind? Obviously it is designed by nature for use in those industries which require continuous power, that is, for electrochemical and electrometallurgical processes. In what way can a kilowatt-hour of Niagara power be used for the greatest good? Is it desirable that it be carried to some distant point such as Windsor or Sarnia, with a loss of 15 or 20 per cent, and there dissipated in wasteful and extravagant lighting under what amounts to a government subsidy? Should it even be sent to Toronto to be used in the pumping of water at a cost greater than could be accomplished by steam power? Is it even desirable that this power be sold for public service purposes near at hand at prices so low as to promote carelessness and wasteful extravagance? Would it not be better to distribute this power for such purposes only to such distances as can be done economically, in proper competition with other sources, and to sell it only at such prices as will promote economical use, and to utilize the greater part of it at the source in the manufacture of abrasives, ferrosilicon, fertilizers and a thousand and one other products which are being made at Niagara Falls, N. Y., and which are of such importance in the modern industrial world? Modern civilization is dependent on these things. Take ferrosilicon, artificial abrasives, and aluminium away from the automobile industry, for instance, and what would be the result? Quantity production, as we now know it, would be an impossibility. We have it on authority that weights would be increased over 80%, production would be reduced by about 80%, and prices would go out of sight. The same would be true in greater or less extent all down the line. Practically everything we use would be affected, even to our food, into which these things enter in the form of farm machinery, tractors, fertilizers, etc.

Results of Failure to Co-ordinate Power and Industry

The fallacy of the thing has been made fairly obvious by the demands of this war. What has happened? Why, people have been exhorted to reduce their lighting in order that industries making munitions, principally ferrosilicon and similar products, might have the power. Street lights have been slashed right and left for the same purpose. Streets have been left in darkness till

late at night, whole sections of cities have been cut off from their lighting circuits in the day time and deprived of the use of their electric irons, toasters, vacuum cleaners, etc., for hours at a time in order that electrochemical industries might have the power. On the one hand people are being exhorted to use power, to buy electric power-consuming devices, and on the other are being deprived of the power that they have been exhorted to use. To be sure, this is a war condition, but war or peace, is the principle any different? Will not the same conditions exist ultimately under peace conditions?

Well, how are we going to accomplish this co-ordination of power and industry? Shall we depend on public ownership to do it? Public ownership is doing just the opposite. Most of the economic crimes which have been committed in connection with hydro-electric power have been committed by public ownership.

Just a word as to public ownership. Its slogan is "Power at Cost." Well, what is "cost"? It is likely to be something quite different under public ownership from what it is under private ownership, but you're not supposed to know that. You are supposed to be hypnotized by the thought of getting power at cost and made extremely joyful at the prospect of depriving some criminal corporation of its ill gotten gains. Well, what happens?

In a private corporation no project is entered into without thorough study and investigation of plans, methods, costs, probable earnings, etc., etc. The success or failure of the undertaking depends on the accuracy of these estimates, as there is always competition to be met.

Under public ownership and the "power-at-cost" principle, what happens? Well, it's "power at *cost*." The people have got to foot the bill anyhow, so why worry about the cost and why go to all the labor and pains to make careful estimates and well considered plans? Rough estimates will do—all they are for anyhow is to serve as a basis for an appropriation. Make them as low as possible so as to make it look attractive, because after the work is started it will have to be finished anyhow, whatever it costs. And, as to plans, why bother about extensive investigations; probably the different schemes will not differ much in cost anyhow, and as the cost has got to be paid, whatever it is, why go to all that unnecessary work. It is very easy to explain to a gullible public that the high cost was due to the increase in the price of materials and labor or something else. The result is likely to be "Power at Cost" with the accent on the *cost*. The legitimate profit which the private corporation would make by careful and efficient management is probably more than swallowed up in the wasteful and extravagant methods of the publicly owned undertaking, but the public doesn't know that, so is perfectly happy—for a while.

As a matter of fact it is well known that long distance power transmission enterprises have not been particularly successful financially even under private ownership, such profits as have been made being small even under the most economical management possible. That any substantial reduction in actual cost to the consumer in such enterprises can be effected by public ownership is extremely unlikely.

There are ways, however, in which the illusion can be kept up. For instance, in a certain city where public ownership prevails, power is sold to lighting customers at two cents per kw.-hr. up to a certain point, with a reduction to one cent for all excess. The waterworks department of this same city is required, against its own desire, to use large amounts of electric power for pumping, and for that service is charged the equivalent of 2½ cents per kw.-hr. Also this same city has installed an extensive and extravagant street lighting system which also forms a very convenient dumping ground for the excess power costs. The tax rate of this city this year was about thirty mills, of which one mill or about 3 per cent was to pay for deficits on its publicly owned utilities.

A second objection to government ownership—unless it is complete, an absolute monopoly—is its injustice. All public service corporations are subject to government regulation whenever the government chooses to exercise it. For the same government to enter into competition with the same corporations which it has the power to regulate, is manifestly unjust and leads to all sorts of abuses for which there is no redress.

It is impossible to keep politics out of publicly owned utility, or to keep the utility out of politics. A power monopoly, particularly, offers too easy an opportunity for unscrupulous politicians to establish and maintain undue political, social and economic power over a large population. With such an instrument being used for political purposes its policies, purposes and methods take on a political complexion, and even problems which should belong solely to the realms of engineering and economics are decided by political considerations.

For instance, the transmission of Niagara power to Sarnia, a distance of nearly 200 miles, where they had a perfectly good, brand-new, up-to-date steam-turbine electric plant, which was deliberately put out of business thereby, can hardly be justified on either engineering or economic grounds.

Another objection to public ownership is its apparent inability to keep ahead of the game. It is always scurrying to keep up with the procession. It falls into the never ending circle of scurrying on account of lack of foresight, and lack of foresight on account of being always scurrying. Consequently it is always facing a crisis of some sort due to its failure to prepare in advance. This condition may be partly due to inferior personnel, partly to playing politics, and partly to lack of authority to spend money or ability to obtain authorization from the legislative body for the expenditure of money for future requirements; but whatever the cause, it is a condition which exists.

However, there is a strong trend toward public ownership. If we are to have it, let's go into it with our eyes open, and when we are in it, let's insist that it be open and above-board. Personally I do not think we can look to public ownership for the solution of the problems of correlating hydro-electric power and industry.

What then can be expected of private ownership? I believe private ownership has done very well. The bulk of the power generated at Niagara, on the American side, is used for the purposes nature intended. A certain amount, to be sure, is transmitted away for public utility use, but this is perfectly legitimate, as it is right and proper that enough of the power should be used in this way to supply the reasonable needs of the people within reasonable transmission distance. Also a steam

station has been built to supply further requirements in this respect. This also, in my belief, is quite as it should be. Steam power is quite suitable, and can be supplied at reasonable cost commensurate with the service rendered, for such industries and utilities as are, or will be, located at Buffalo.

Further development at Niagara should be reserved for those industries requiring large quantities of cheap continuous power for the manufacture of important—nay, indispensable—materials of industry, materials which are so vitally needed at the present time.

What, then, of the government? Is there no function which it should perform in this important matter? I believe that there is. It should see that water power is developed with reasonable economy and utilized to the best advantage. It should establish a commission on this correlation of hydro-electricpower and industry, which should make a thorough study of the water powers of the country with a view to their early and proper utilization. It should seek to bring together industries seeking power and water powers seeking customers, to the end that the water powers of the country may be put to those uses to which they are individually best adapted, and that industries may find inconsumable power sources suited to their needs. So far as water powers on the public domain are concerned, it should promote their utilization under conditions sufficiently favorable to attract capital and under such restrictions as may be necessary to guard the public interest. In all these matters it should adopt a constructive policy designed to promote in every legitimate way the proper and immediate development and utilization, under private ownership, of the country's vast water power resources.

The Possibilities for the Development of Chemical Industries in the Southern States

By RICHARD K. MEADE

ALL things in the South either begin or end with the Civil War. When Lee surrendered at Appomattox, the old South died and the new South was born. The old South was primarily an agricultural community. While here and there a Welsh, Swedish or German colony scratched the hillsides for iron ore and smelted this with charcoal in primitive furnaces, the great mass of the population was dependent on agriculture for a livelihood. There was almost no manufacturing carried on in the States comprising the Confederacy. The cotton which was raised was sent north to be woven into cloth by the looms of New England and vast other sources of raw material lay untouched.

With the fall of the Confederacy, the new South was born. The child naturally inherited some of the characteristics of the parent, but it also began to develop talents of its own, and while the South is still a great agricultural community, producing as it does more than half of the total value of the farm products of the country, its mineral and other resources are rapidly being developed and turned into manufactured articles in Southern plants and workshops.

The new South has passed through all of the phases of childhood to its present well-developed manhood. The reconstruction era was its cradle period and the closing years of the eighteenth century found it just beginning to walk. Until quite recently, its young men who were technically inclined, discouraged by the few openings for the display of their skill and energies in the states of their birth, emigrated to the West and opened up mines or came north and dug tunnels under the Hudson River or fixed nitrogen from the air at Niagara Falls.

With nearly a third of the population of the United States within the South, the total capital invested in manufacturing throughout this whole region is but little greater than that invested in such enterprises in the State of Pennsylvania alone. The six Southern states, Virginia, North Carolina, South Carolina, Georgia, Alabama and Tennessee, which are richest in mineral resources, have less capital invested in manufacturing than Massachusetts, and yet the latter state is almost without any natural advantages in raw materials.

In considering the South, therefore, as a manufacturing center, we must view it rather as to its future possibilities than from any past performances, in spite of the fact that the growth of manufacturing in the new South during the last two decades has been rapid.

There are now manufactured in the Southern states a considerable amount of iron and all of the cement which is needed in this territory. The coal dug from Southern hillsides today is greater than that mined throughout the whole United States twenty years ago. Practically all of the phosphate rock in this country comes from the South and the oil wells of this section produce more than half of our petroleum.

At the risk of boring the reader by enumerating well-known resources of the South, it may be said that this section grows the entire cotton crop of the country. About half the standing timber of the United States is found within its borders. It produces three-fourths of the sulphur of the world and dominates the world's sulphur trade. It furnishes a third of the world's output of oil and scientists put the possible production from existing Southern fields at more than four billion barrels of petroleum. The Southern coal fields extend over 88,000 square miles, a coal area many times greater than that of the French provinces, desire for which excited Prussia to war in 1871. In fact, the Southern coal area is twice that of Europe and contains approximately three-fourths of the coking coal of our nation. Over 5,000,000 horse power await the harnessing of Southern streams. The South is the greatest producer of bauxite for the manufacture of aluminium and of barytes for the production of chemical pigments.

The question of the better distribution of chemical and metallurgical industries throughout the country, so that instead of being located along the Atlantic Seaboard where they would be subjected to easy capture on invasion has been so thoroughly discussed by the press during the last two years, that it is hardly necessary in this short article to do more than call attention to the fact that the Government has located both its powder plant and its nitrate plant within the South far removed from the Atlantic Seaboard. Anyone who has crossed the towering ramparts of the Allegheny Mountains to either one of these sites, can bear testimony to the ease with which these localities could be defended.

Power and Fuel

The primary consideration in the establishment of electrochemical industries must of necessity be the cost of power. In the manufacturing sections of the North, where fuel is comparatively dear, practically all electrochemical industries are dependent upon water power. In certain parts of the South, however, very cheap fuel is obtainable and in such sections steam power could, by the installation of efficient power plants, be put on a cost-footing favorable with water power.

In view of the high cost of developing water power, and the fact that most chemical industries had rather purchase this than go to the expense of developing water power themselves, it would seem that for those who are using a moderate amount of electrical power, there would be great possibilities in the utilization of some of the cheap fuels of the South in this direction. The first cost of even the best steam plant will be far below that of the development of the average water power.

Cheap coal is obtainable nowhere just now, but when conditions are favorable, power plants located in the coal fields of the South can, if properly equipped and managed, furnish power at a figure not entirely out of the competition with water power, particularly when the cost of the development and maintenance of the latter is considered and properly taken care of in estimating the price of such power. At Kingsport, Tenn., there is a large steam-power plant which furnishes current for several chemical and electrochemical operations in that section. It is estimated that under normal prices for coal and labor, current can be produced from coal in favorable localities in the South for about three mills a horsepower-hour which is equivalent to about $30.00 a horsepower-year.

To those, however, who feel that they must have water power in order to put their process on a commercial footing, the South offers plenty of undeveloped power. In this connection it might be well to point out that in the mountainous portions of eastern Tennessee, western North Carolina and South Carolina, northeast Georgia and northeast Alabama, the rainfall is greater than that in any other section of the United States and that in this region the climatic conditions are ideal for the maintenance of power transmission lines. The great power streams of the South are the Cumberland, Tennessee, Coosa, Ocmulgee, Saluda, Yadkin, Broad, Catawba, Roanoke, James, Kanawha, New, Pee Dee, Savannah, Tallapoosa, Neuse and Cape Fear.

The greatest power development in the South has been in southeastern North Carolina on the Saluda, the Broad, the Catawba and the Yadkin Rivers. As we have stated it is estimated that the undeveloped power in the Southern rivers amounts to at least 5,000,000 hp. This is about ten times the power now developed at Niagara Falls and is about equal to all the water power at the present time developed in this country. Of this latter, however, not more than 25 per cent is used by manufacturers and a still smaller portion by chemical manufacturers, the lion's share being employed for public utility purposes such as lighting and street railways.

In the territory where the coal fields of Virginia, Kentucky and Tennessee join, is to be found probably a greater proportion of mineral wealth, including salt, than underlies any other section in the world, and the coal here is of the very best grade for steam purposes. It can usually be obtained for $1.00 per ton at the mine. This and also the Birmingham locality and the lignite fields of Louisiana would seem very promising sections in which to establish electrochemical industries employing steam-generated current or chemical plants in which fuel is a considerable item.

Natural gas occurs at numerous points in the South, and West Virginia was the birthplace of the industry in America. Most of this gas now utilized in ways profitable enough to make its employment for power for electrochemical work out of the question. In northern Louisiana, however, we have the great Caddo gas fields and in Texas the Corpus Christi gas district. The Caddo gas is 95 per cent methane and the geological indications are that a supply of long duration is obtainable here. The gas from this field is now used only for domestic and small manufacturing purposes but here would seem to be obtainable cheap power by utilizing the gas directly in gas engines. Incidentally limestone is found close at hand and of course salt occurs in large quantities in southern Louisiana.

Basic Raw Materials

Coming next to the question of the supply of those basic raw materials which play so prominent a part in the chemical arts generally, such as coke and coal products, salt, sulphur, limestone, wood, etc., we will see what a vast storehouse of these the South really is.

We have mentioned the unlimited supply of coal to be found here. Coke is manufactured pretty generally throughout this area, principally in bee-hive ovens. There are some by-product plants, however, notably those around Birmingham, Ala. While, of course, present outputs probably are contracted for, in normal times benzol and toluol could be obtained from these sources, and no doubt other by-product ovens will also follow in the course of time. Edison built his own plant at Woodward, Ala., from which he obtained benzol for his phenol. The South now recovers about 20 per cent of benzol produced in the country.

Limestone, the basis of many chemical and electrochemical industries, is found in beds extending in an almost straight line through West Virginia and Tennessee, eastern West Virginia, the northern corner of Georgia and central Alabama. Another bed extends through central Tennessee and Kentucky, almost the whole of Missouri and the northern part of Arkansas is also underlaid with limestone. A soft limestone or marl also occurs in central Florida. Both high-calcium

and high magnesium limestone are found in this territory and high-grade lime is obtainable from both varieties. Lime from the Virginias is shipped to Niagara Falls for the electrochemical industries and to the chemical plants in New Jersey.

Salt is now produced in Louisiana, Virginia, Texas, West Virginia and Oklahoma to the value of about $1,000,000. The supply in both Virginia and West Virginia is near water powers available for development and in a locality where fuel is cheap. The deposits themselves are practically of unlimited extent. The Weeks Island, La., salt has a purity of over 99½ per cent sodium chloride, while the West Virginia brines contain considerable bromine and calcium chloride, both of which are recovered and marketed. Soda-ash and soda products are made at Saltville, Va., by the Mathieson Alkali Works, one of the largest producers of such chemicals in America.

Sulphuric acid is the basis of so many chemicals that a supply of this is almost essential to the establishment of a chemical industry in any section. As I have said, Louisiana controls the sulphur trade of the world. Also the largest by-product sulphuric acid plant in existence is at Ducktown, Tenn., in a region abounding in mineral resources. Owing to the fact that plants which sold acid to fertilizer factories, at the outbreak of the war diverted their outputs to munition plants, many of the large fertilizer manufacturers in the South were either forced to build acid chambers, or else found it profitable to do so. The result of this will be that with the end of war there will be a very large over production of sulphuric acid in the South.

Virginia has long been known as the most important domestic producer of pyrites, the value of the output of its mines now being over three-quarters of a million dollars. Georgia also produces some pyrite and there are important undeveloped deposits of this mineral in both of the Carolinas. The only domestic producer of arsenic direct from its ores is located in Virginia.

As I have said, the South has over half the standing timber of the country and this latter comprises both hardwood suitable for distillation and the soft woods for pulp, paper and cellulose compounds. The recovery of turpentine from pine tags is now practical and the South has always been the important domestic producer of this material. Tanning extracts are also important Southern products. Those chemicals made from cotton and crude and refined oils made from cotton seed, including the hydrogenation products of the latter oil, should of course form important Southern industries. Important deposits of fuller's earth for cotton-oil purification are found in Florida which is the leading producer in the country and also in Georgia, Texas and Arkansas.

Special Resources

Many plants of medicinal and industrial value now supposed to be only indigenous to certain foreign climes can be raised profitably in the South. The castor-oil bean is one of them and I believe is to be extensively raised this season to furnish oil for aeroplanes. Medicinal plants which can be grown in the central South are digitalis, Indian hemp, hydrastis, belladonna, gentian, horse mint and a host of others. Camphor is now grown along the gulf coast and in Florida and even tea has been raised in South Carolina.

Red and brown hematite ores extend in an almost unbroken belt from Virginia to central Alabama. The red ores carry considerable carbonate of lime and are hence known as self-fluxing ores. For the production of ferro compounds from these ores, we have, in regions where cheap water power abounds, many of the necessary minerals. For the production of ferro-silicon, quartz and quartz sand are found in many parts of the South, notably Virginia, Georgia and North Carolina. Very pure quartz in massive deposits can be found in the latter state. A large part of the titanium now used for steel making comes from Virginia and in the neighborhood from which the present supply is obtained numerous undeveloped properties occur. Chrome ore for the manufacture of ferro-chromium is found in North Carolina but so far the deposits are undeveloped, or for that matter even thoroughly explored, so it is hard to say what the value of these is. Molybdenum occurs in Texas and is now being mined in that state. The phosphate rock for the present supply of ferro-phosphorus, of course, comes from Florida and Tennessee. Extensive manganese deposits occur throughout many parts of the South, notably in Georgia, Arkansas and Virginia. So far, however, none of these deposits has been very extensively developed although they unquestionably represent possible sources of this metal of great value.

The South has long been recognized as the big producer of bauxite, the ore of aluminium. Practically all of this ore, however, has been sent North for working into the metal until recently when the Aluminum Company of America began developments in North Carolina. Arkansas now produces about 90 per cent of the bauxite of the country, while the balance comes from Tennessee and Alabama.

The phosphate resources of Florida and Tennessee are too well known to need more than mention here. It may be said, however, in passing, that the South is the largest user of fertilizer in the country, yet it has purchased its nitrogen from Niagara Falls and Chile in spite of the immense deposits of limestone and coal which traverse this section and of the fact that its inhabitants claim that Southern air is purer than that found anywhere else in the world.

Practically all of the barytes now used in American plants comes from the South largely from Missouri, Tennessee and Georgia. No doubt when Austrian ores again enter this country, the plants along the Atlantic Seaboard will be supplied from this source but there is no reason why local manufacturing plants should not develop in the states mentioned for the manufacture of barium compounds. Fuel and labor here are cheaper and the necessary zinc for lithophone can be found in southwestern Virginia and eastern Tennessee. I believe that the zinc manufactured here is purer than that found anywhere else in this country.

As to other minerals, Georgia produces more asbestos than any other state; Kentucky furnishes fluorspar; Alabama, North Carolina and Virginia all have large deposits of graphite some of which are being worked; gypsum suitable for plaster manufacture is obtained in Virginia, Texas and Oklahoma and celestite the ore of strontium is found (but not so far worked) near Austin, Tex.

Clays suitable for pottery, brick and terra cotta

abound in the South and some of the finest feldspar deposits are also located here. Materials for the manufacture of Portland cement are abundantly distributed and cement and other building materials are everywhere easily available at fair prices.

Labor Markets and Transportation

After all in considering manufacturing operations, one of the most important essentials is labor. The writer has been doing considerable construction in both the North and the South during the last few years and he has found the labor problem more acute in the North than in the South. Good intelligent labor can be obtained in the South at a much lower wage than in the North. Housing conditions are much simpler and the manufacturer who is forced to establish his own colony, will appreciate the advantage of the simpler construction required for this mild climate. The cost of living is also much less in the South than in the North owing to the large supply of farm products which are near at hand and the distance to which these must be sent in order to find a high-priced market.

Another vital problem in the establishment of industries is transportation. Southern railroads have usually been considered more or less of a joke. This is the old story, however, of sending out the truth to catch a lie. The amount of railroad development which has been done in the South in the last ten years is very extensive. The Norfolk and Western Railroad is now recognized in railroad circles as second to none in the country for good management. The Southern, the Chesapeake and Ohio, the Louisville and Nashville railroads and contributing lines to these are now being brought up to a high state of efficiency.

As to markets, except when made for personal consumption, no one would care to manufacture anything if he could not sell it. No matter what the resources of a section are there must be a market place for its produce if it is to prosper. The South has a population of thirty millions who eat, drink, sleep, work and play very much as do the other seventy million Americans. Much of the output of its new chemical plants should be used at home therefore and the great central West is also more easily reached from the northern part of this section than from eastern chemical centers. The chemical industry is a very complicated and intricate structure and often the product of one branch of chemical endeavor finds its way into another. Consequently as each new chemical plant starts operation it will create a demand for another.

Summary

To sum up, it would seem that the South offers excellent opportunities for the manufacture of carbide and for the fixation of atmospheric nitrogen in the form of cyanamid owing to the possibilities of developing cheap power adjacent to inexhaustible supplies of limestone and coal; for the manufacture of aluminium and ferro-alloys in the electric furnace; for the production of phosphate compounds and fertilizers; for the manufacture of barium products including lithopone, owing to the presence of all the raw materials necessary for these in adjacent localities; for the manufacture of soda-ash and other chemicals from salt owing to the extensive brine deposits in certain southern states; for the manufacture of wood chemicals, wood pulp and cellulose substitutes because of the vast amount of timber now standing in this section; for the making of dyes from coal-tar residues; and for industries which will utilize by-product sulphuric acid.

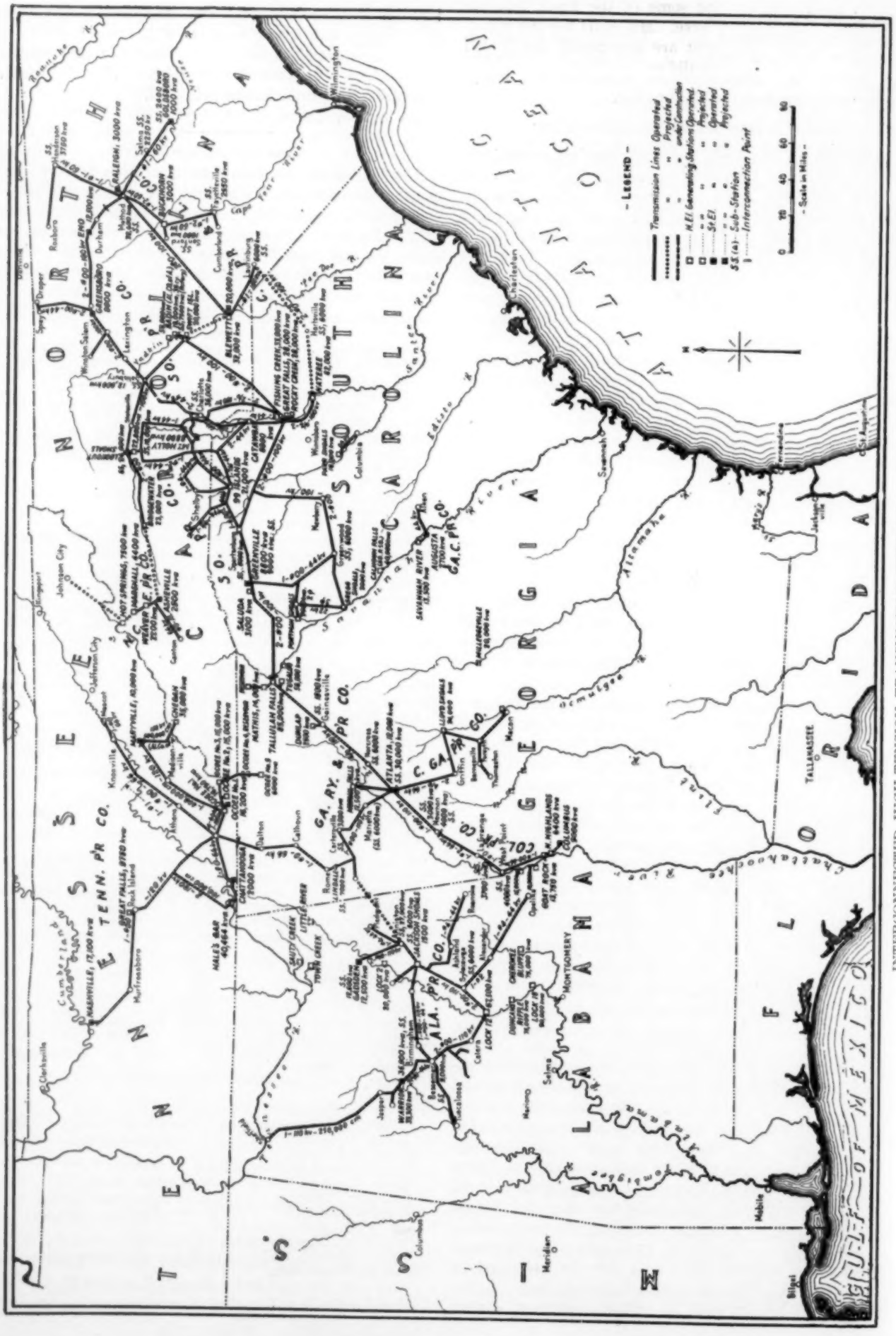
Law Building, Baltimore, Md.

New Priorities List

The United States Fuel Administration will be governed in the distribution of coal and coke by a slightly amended list of priorities recently arranged by the War Industries Boad. Not only will the industries coming under the new classification be given preferential treatment by the Fuel Administration but also in transportation by the railroads.

Aircraft: Plants engaged exclusively in manufacturing aircraft or supplies and equipment therefor.
Ammunition: Plants engaged in the manufacture of ammunition for the United States Government and the allies.
Army and Navy cantonments and camps.
Arms (small): Plants engaged in manufacturing small arms for the United States Government and the allies.
Chemicals: Plants engaged exclusively in manufacturing chemicals.
Coke plants.
Domestic consumers.
Electrical equipment: Plants manufacturing same.
Electrodes: Plants producing electrodes.
Explosives: Plants manufacturing explosives.
Farm implements: Manufacturers exclusively of agricultural implements and farm operating equipment.
Feed: Plants producing feed.
Ferro-Alloys: Plants producing.
Fertilizers: Manufacturers of fertilizers.
Fire brick: Plants producing exclusively.
Food: Plants manufacturing, milling, preparing, refining, preserving, and wholesaling food for human consumption.
Food containers: Manufacturers of tin and glass containers and manufacturers exclusively of other food containers.
Gas: Gas producing plants.
Guns (large): Plants manufacturing same.
Hemp, jute, and cotton bags: Plants manufacturing exclusively hemp, jute, and cotton bags.
Insecticides: Manufacturers exclusively of insecticides and fungicides.
Iron and steel: Blast furnaces and foundries.
Laundries.
Machine tools: Plants manufacturing machine tools.
Mines.
Mines: Plants engaged exclusively in manufacturing mining tools and equipment.
Newspapers and periodicals: Plants printing and publishing exclusively newspapers and periodicals.
Oil: Refineries of both mineral and vegetable oils.
Oil production: Plants manufacturing exclusively oil well equipment.
Public institutions and buildings.
Public utilities.
Railways.
Railways: Plants manufacturing locomotives, freight cars and rails, and other plants engaged exclusively in manufacture of railway supplies.
Refrigeration: Refrigeration for food and exclusive ice-producing plants.
Seeds: Producers or wholesalers of seeds (except flower seeds).
Ships (bunker coal): Not including pleasure craft.
Ships: Plants engaged exclusively in building ships (not including pleasure craft) or in manufacturing exclusively supplies and equipment therefor.
Soap: Manufacturers of soap.
Steel: Steel plants and rolling mills.
Tanners: Tanning plants, save for patent leather.
Tanning extracts: Plants manufacturing tanning extracts.
Tin plate: Manufacturers of tin plate.
Twine (binder) and rope: Plants producing exclusively binder twine and rope.
Wire rope and rope wire: Manufacturers of same.

Non-ferrous metallurgical plants are not on the list.



INTERCONNECTED HIGH-TENSION TRANSMISSION SYSTEMS OF THE SOUTH

Interconnected Power Systems of the South

Hydro-electric Systems of Independent Companies Operating in Five States Are Connected Into One Vast Transmission System

HYDRO-ELECTRIC power is a resource that will attract to a community a line of manufacturing and chemical industries that usually seek cheap power as the prime requisite. The development of high-tension transmission systems has become common in many parts of the United States, but it was in the South that the logical and obvious thing was first done by interconnecting a number of systems with resultant advantages and economies. As shown on the map on the opposite page the Southern states can boast a high-tension line approximately 1000 miles long from Nashville, Tennessee, to Henderson, N. C. This ties together the hydro-electric systems of five companies operating in four states. In other words, all the great transmission systems of the South with the exception of that controlled by the Alabama Power Company are interconnected. It is probably only a question of time until all properties will not only be interconnected but possibly owned and controlled by a master organization.

Among the advantages which follow from the interconnection of such systems none is greater than the improvement in the diversity factor. The difference of one hour in time between Henderson, N. C., and Nashville, Tennessee, adds to the normal diversity factor of each system.

The United States Geological Survey has estimated the available power in the headwaters of the Appalachian mountains at 2,800,000 hp. The estimate for all the systems of the South is about 5,000,000 hp. The Appalachian region has an enormous rainfall with a topography that is favorable to the development of low-head power plants. The illustration at the head of this article is typical of the Southern water powers. High heads as a rule do not exist and flumes and penstocks are little used. The absence of lakes in the region makes natural storage of water impossible.

Among the power companies in the United States and Canada having yearly outputs in excess of 100,000,000 kw.-hr., there are three Southern concerns, according to data given in the *Electrical World*, March 23, 1918.

System	Peak Load, Kw.	Yearly Output, Kw.-Hr.	Yearly Load Factor Per Cent.
Tennessee Power Co.	85,200	547,945,475	73.41
Alabama Power Co.	58,250	289,715,125	56.7
Georgia Railway & Power Co.	78,200	258,607,882	.....

INTAKE DAM AT TALLULAH FALLS, GEORGIA RAILWAY AND POWER CO.

Alabama Power Company

The properties owned by the Alabama Power Company[1] include several sites on the Coosa River, one site on the Tallapoosa River, a site on Little River, and sites at Muscle Shoals on the Tennessee River. On these sites approximately 500,000 hp. can be developed. The hydroelectric stations of the company at present in operation are located at Lock 12 on the Coosa River, where a head of 68 ft. is available, and at Jackson Shoals, on Choccolocca Creek, where a head of 22 ft. is available. Sixty-cycle, three-phase energy is generated at 6600 volts in the Coosa River plant and 2300 volts in the Jackson Shoals plant. The company has at present in operation 180 miles of steel-tower transmission lines equipped with suspension-type insulators and 00 stranded copper cable for transmitting energy at 110,000 volts to four substations over private rights-of-way. The substations are situated at Gadsden, Anniston, Jackson Shoals and Magella near Birmingham. Substations operated at 22,000 volts are in operation at Talladega, Leeds, Lovick, Alexander City, Gadsden and Attalla. The high-tension substations

COLUMBUS POWER CO.

are of the outdoor type. It is the purpose of the company to standardize these as to size and type on 3000, 6000 and 10,000-kva. ratings. At present 45,300 kva. is installed in the four substations. The company has 25,000 kw. of available steam auxiliary apparatus, comprising a 12,500-kw. steam turbine station at Gadsden, containing two 6250-kva. units, and a 15,000-kw. steam turbine and reciprocating engine plant. With the available steam auxiliary of 25,000 kw. operating as required and furnishing approximately 7.55 per cent of the total kilowatt-hour output, 62,400 kw. of primary power at 50 per cent load-factor can be delivered as soon as another hydro-electric unit is installed. The Anniston substation is a switching station for two 110,000-volt lines which pass through it. The Jackson Shoals substation is also a switching station for three 110,000-volt circuits from the north, south and west. The Magella substation will have an ultimate rating of 67,000 kw.

[1]Interconnected Systems of the South, Electrical World, May 30, 1914.

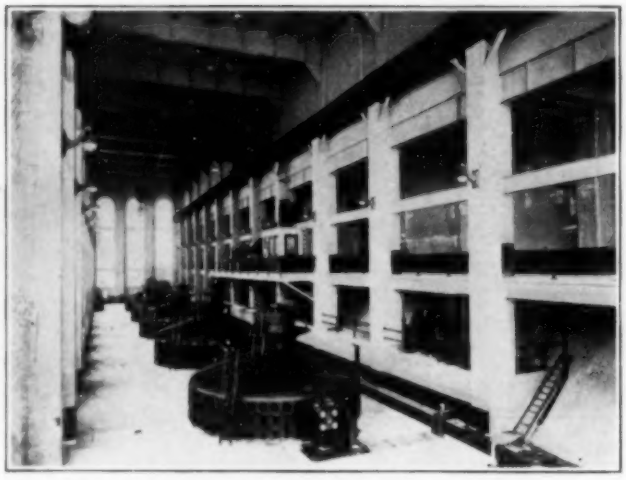
YADKIN RIVER POWER COMPANY, BLEWETT FALLS, N. C. HYDRO-ELECTRIC PLANTS FROM NORTHEAST

Carolina Power & Light Company

The Carolina Power & Light Company, in addition to the property owned and directly operated, also controls the Yadkin River Power Company and the Asheville Power & Light Co.

The Carolina Power & Light Company operates the electric light and power service in Raleigh, Goldsboro, Henderson, Oxford, Sanford, and Jonesboro, furnishing electric light and power service for manufacturing properties in Fayetteville, Clayton, Smithfield, Selma, Franklinton, Pine Level and Cumberland. It also supplies under contract the entire requirements of the municipal electric light and power systems in Smithfield, Selma and Clayton and all the privately owned electric light and power systems in Franklinton and Pine Level. The company operates 188 miles of high-tension transmission line connecting two hydro-electric and three steam plants with distributing systems in all the communities served. The larger of the hydro-electric plants is located at Buckhorn Falls on the Cape Fear river and has an installed capacity of 3,300 horsepower. The smaller is a plant of 530 horsepower on the Neuse River near Raleigh. The company has also in reserve a modern steam plant of 5,000 horsepower ca-

GREAT FALLS PLANT OF THE SOUTHERN POWER COMPANY



90,000-HP. GENERATORS—COOSA RIVER INTERIOR VIEW LOCK NO. 12 POWER HOUSE

pacity at Raleigh, one of 950 horsepower at Goldsboro and one of 300 horsepower at Henderson. It operates nine substations with an aggregate capacity of 23,000 horsepower.

The properties of the Carolina Power & Light Company are located in the heart of the North Carolina industrial district. A large part of the electric energy sold by the company is supplied to cotton mills, cotton gins, cotton-seed oil mills, fertilizer works, veneer mills, furniture factories, machine shops, brick plants and other manufacturing establishments, and to municipalities for pumping water.

Yadkin River Development

The Yadkin River Power Company owns and operates a hydro-electric development located on the Yadkin river, at Blewett Falls, near Rockingham, North Carolina, with an initial installed capacity of 32,000 horsepower. It has in operation 184 miles of high-tension transmission lines, located on private right-of-way, and 49 miles of distributing lines, five substations, with a total capacity of 4,100 horsepower; and lighting and power systems in Rockingham, Hamlet, Wadesboro and Lilesville, North Carolina and Cheraw, South Carolina, and an electric power service in Lumberton, North Carolina. The transmission lines are connected with those of the Carolina Power & Light Company and the Southern Power Company. The power station at Blewett Falls is one of the most modern stations in the South. It is 285 feet long by 70 feet wide, three stories in height, and is built of steel and brick with concrete foundations, floor and roof. The dam is of solid concrete construction. It has a total length of 1,470 feet and a maximum height of 50 feet. The dam has created a reservoir eight miles in length with a total area of 2,500 acres. The station was placed in regular operation in June, 1912.

Like the properties of the Carolina Power & Light Company, those of the Yadkin River Power Company are located in the Carolina cotton-mill district, and a large part of the electric energy sold by it is supplied to cotton mills, cotton gins and cotton-seed oil mills. It also supplies power to numerous other industrial plants, such as fertilizer works, veneer mills, furniture factories, brick plants and railroad shops, and to municipalities for pumping water.

Columbus Power Company

The Columbus Power Company[2] has three hydro-electric developments on the Chattahoochee River, two at Columbus having an aggregate rating of 9000 kva. and one at Goat Rock, 15 miles north of Columbus, having 13,750 kva. installed, making the total available 22,750 kva. The City Mills development at Columbus comprises five generators with an aggregate rating of 1000 kw., the head being 10 ft. The North Highlands development has six generators, with an aggregate rating of 6900 kw., and waterwheels operating under a head of 42 ft. The Goat Rock development, where a head of 72 ft. is available, has three generators, two of which are rated at 3750 kw. and the other at 5000 kw. Three-phase, sixty-cycle energy is generated at 5500 volts and 11,000 volts. Two 4000-kw. transformers step up the potential to 66,000 volts for transmission. A 11,000-volt line on wooden poles with pin-type insulators connects the Columbus and Goat Rock properties, and a 60-mile steel-tower line equipped with suspension-type insulators and operating at 66,000 volts extends from Goat Rock at Newnan. There is

DUNLAP PLANT, GEORGIA RAILWAY AND POWER CO.

[2] Ibid.

ROCKY CREEK PLANT OF THE SOUTHERN POWER COMPANY

LOCK 12 HYDRO-ELECTRIC PLANT—DOWN-STREAM VIEW

18 miles of wooden-pole line operating at 11,000 volt connecting Newnan and Hogansville. Four main substations are connected to the system, one at Columbus rated at 1600 kw., one at West Point rated at 1875 kw., one at La Grange rated at 1875 kw. and the fourth at Newnan rated at 4000 kw. The system operates continuously on a 40 per cent load-factor basis, and auxiliary steam generating apparatus of the capacity of of 3000-kw. turbo-generators is available. Provision is made for the transfer of 3000 kw. between the Columbus Power Company's system and the system of the Georgia Railway & Power Co.

Georgia Railway and Power Co.

The present coal supply conditions emphasize the importance of existing water-power generating plants and the vital need of additional developments.

The 100,000-hp. plant of the Georgia Railway and Power Company at Tallulah Falls was barely finished when the rapid increase in the demand for hydro-electric power forced the company to undertake the construction of additional water-power developments, which, when completed, will nearly double the present capacity of its existing water-power plants.

The growth of the business in the past six years is shown in the following table of yearly outputs in kilowatt-hours:

1912	68,400,642	1915	179,976,596
1913	80,763,025	1916	211,872,638
1914	145,684,803	1917	258,607,802

This shows an increase in that period of nearly 300 per cent or, in other words, the volume of business almost doubled twice.

The water power furnished by the company to its customers in 1917 would have required approximately 475,000 tons of coal if generated by them by steam. The additional water power which it is estimated will be generated at the new plants now under construction, and which has already been largely sold, will take the place of and save approximately 400,000 tons of coal annually—a total combined saving of approximately 875,000 tons of coal per annum.

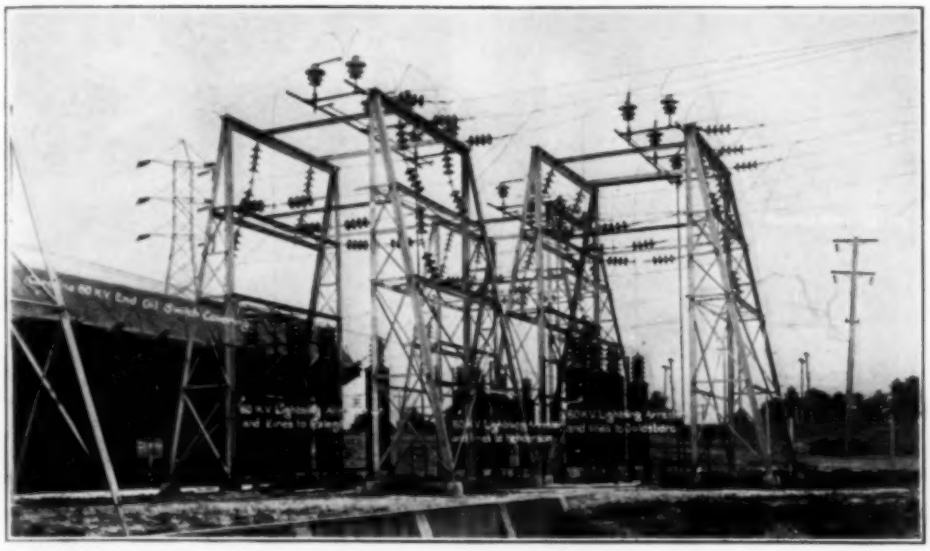
The new developments now being constructed are:

BURTON STORAGE RESERVOIR

(To be in service by the end of year 1918)

The Burton storage reservoir is three miles north of the present Mathis storage reservoir, and will flood approximately 3000 acres of land. It requires the construction of a dam 700 feet long and 100 feet high of cyclopean masonry. The reservoir will store approximately five billion cubic feet of water. The water contained in this reservoir, exclusive of the average flow of the river, will produce at the Tallulah Falls and Tugaloo generating plants 65,000,000 kilowatt-hours and will increase the annual capacity of those plants to that extent. This reservoir will also make possible the equalization of the river flow, or in other words, the even distribution of all available rainfall run-off from

LOCK 12 HYDRO-ELECTRIC PLANT—UP-STREAM VIEW



METHOD, (N. C.) OUTDOOR SUBSTATION LOOKING NORTH. CAROLINA POWER AND LIGHT COMPANY

its contributary water shed throughout every month in the year, the stored water being drawn out for use in the dry months and replaced in the wet season. The water that can be stored in this reservoir is equivalent to the available energy in 130,000 tons of coal.

Tugaloo Development

The Tugaloo development is situated about two miles below the present Tallulah Falls power house on the Tugaloo river where the Tallulah and the Chattooga rivers come together and form the Tugaloo. The water available at this point for power purposes come from both the Tallulah and the Chattooga rivers. The average flow of the river, including the effect of the Mathis storage reservoir, it is estimated will produce at this plant approximately 120,000,000 kilowatt-hours. It will require only one and one-half miles of transmission line to connect this development with the present Tallulah Falls transmission lines. The Tugaloo dam of cyclopean masonry is 800 feet long and 140 feet high. The Tugaloo plant will develop approximately 65,000 hp., and it is estimated that two years time will be necessary in which to complete it.

Sixth Unit

(To be in service during the summer of 1918)

The Tallulah Falls power plant was constructed and designed for six units of 12,000 kilowatts or about 17,000 horsepower each. Five units are now installed. The sixth unit has been ordered and will be ready for service sometime during the summer of 1918.

Contracts were let for all the required equipment for the three developments during the summer of 1917 and construction is now actively under way.

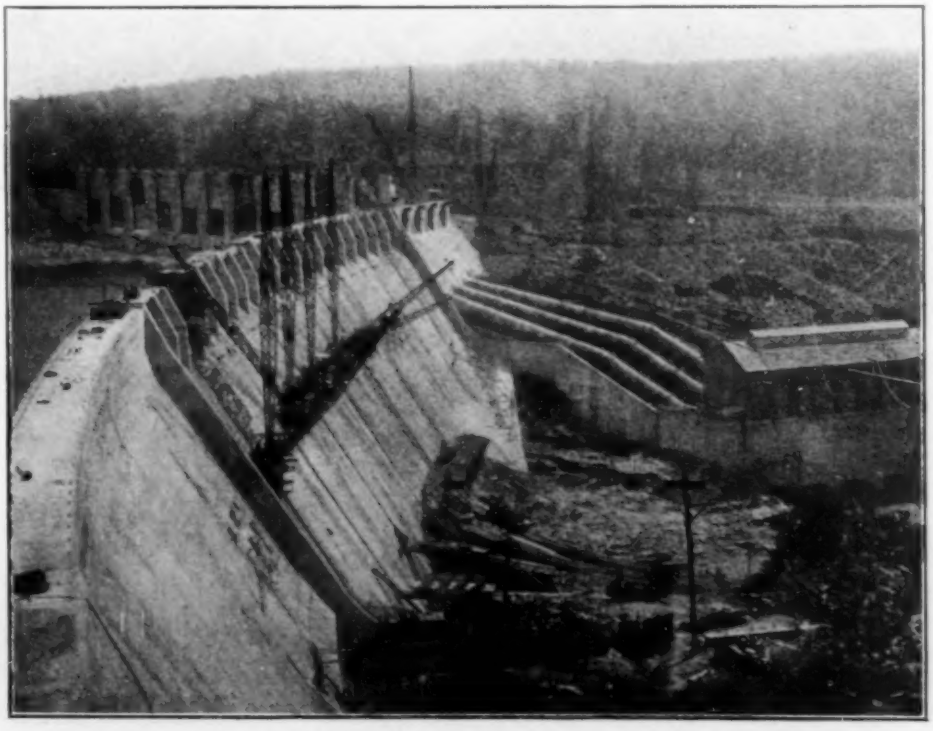
The estimated total cost of this construction is $5,000,000. The necessary financing to carry on the work was completed in June, 1917. The company was fortunate in this respect because the war has since brought such changed financial conditions that the necessary capital could not be secured at the present time and this has been continuously true since the financial arrangements were concluded.

The Georgia Railway and Power Company upon completion of the plants now under construction will have water-power plants of approximately 200,000 horsepower developed and in service.

The company controls approximately 300,000 undeveloped horsepower in addition, or a total developed and undeveloped of approximately 500,000 horsepower.

A very large part of the power generated by the company is being used by enterprises making war materials or supplies necessary to the successful prosecution of the war. This shows how doubly vital it is in war times that money for such developments should be available.

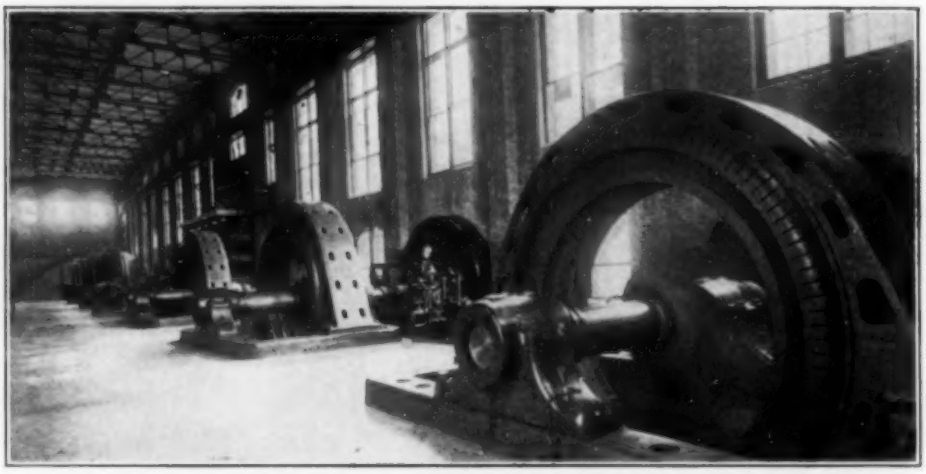
It also points the lesson that many of us appreciated years ago, viz., the necessity of a broad and generous policy on the part of the Government in the development of the water powers of the nation.



THE TALLASSEE POWER COMPANY, YADKIN RIVER, BADIN, N. C.

Water power should be provided to meet the increasing demand due to the war. But war conditions have made money unobtainable through the usual banking channels. From now on and as long as present conditions exist such developments cannot be made unless the national government will furnish the needed capital.

The French government realized early in the war the vital need of largely increasing the available power for industrial purposes from other sources than coal and is now constructing water-power developments in Southern France on a large scale under the direction of an American engineer.



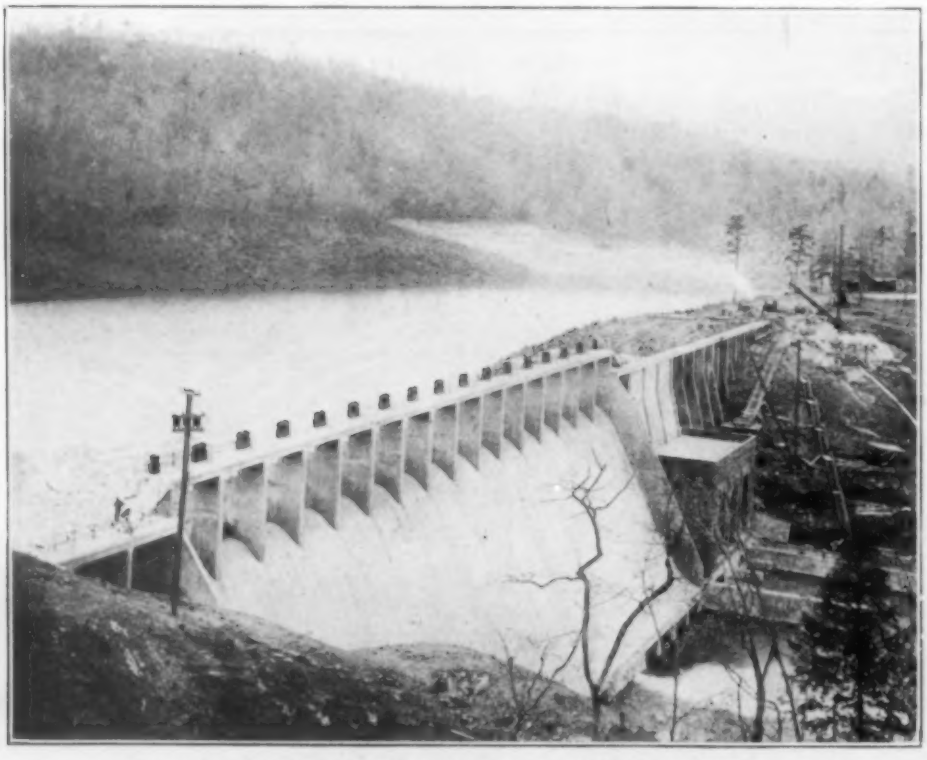
YADKIN RIVER POWER COMPANY. 3-4500 KVA, 3-6000 KVA, 4000 VOLT, 60 CYCLE G. E. GENERATORS

Coal Saved by Hydro-electric Development

The power actually furnished by the Georgia Railway and Power Company, in 1917, if generated by its customers by steam, would have required 11,875 cars of coal of 40 tons capacity each, and the estimated power which will annually be generated by the plants now being constructed, will be the equivalent of 10,000 cars of coal of 40 tons capacity each additional, or a combined saving in coal consumption per annum of 21,875 cars of coal of 40 tons capacity each. If the remaining 300,000 horsepower of undeveloped water power controlled by the company could be developed and put to work, the saving would be two and one-half times as great or a total of 54,687 cars of coal of 40 tons capacity each, or 2,187,480 tons of coal conserved with all its collateral economies.

If capital were now available for the construction of the necessary generating plants sufficient to utilize the undeveloped water power controlled by the Georgia Railway and Power Company, and the national government would bring about the electrification of the steam railroads, all the important railroad mileage in Georgia would be operated by electric power generated by the Georgia Railway and Power Company. The operating expenses of the railroads themselves would be materially reduced, their service much improved, and in addition the coal now consumed by them conserved, and the present regular business of the company supplied and developed as at present.

Our armies at the front will be of no use unless supplied with food and equipment. This necessitates the development and speeding up of most industries to the top notch of production. Business essential to the war must produce as never before to supply our armies at the front, our industrial armies at home, and in addition to furnish taxable values to foot the bills. To this end the efforts of a vast industrial army at home, co-ordinated to supply the needs of the army at the front, are as necessary as the fighting men themselves. Present conditions emphasize the value of water power as never before. Is not this situation deserving of prompt attention by the national government? The President of the United States thinks so, because he called the attention of Congress specifically to the development of water powers in one of his most recent messages.



MATHIS DAM, GEORGIA RAILWAY AND POWER CO.

YADKIN RIVER POWER COMPANY, BLEWETT FALLS, DAM AND POND

Southern Power Company

The Southern Power Company[3] is connected to the Carolina Power & Light Company at a point between Durham and Raleigh, N. C., as indicated on the map, and with the Georgia Railway & Power Company at Tallulah Falls. The location and maximum ratings of the company's various stations are given in the accompanying table.

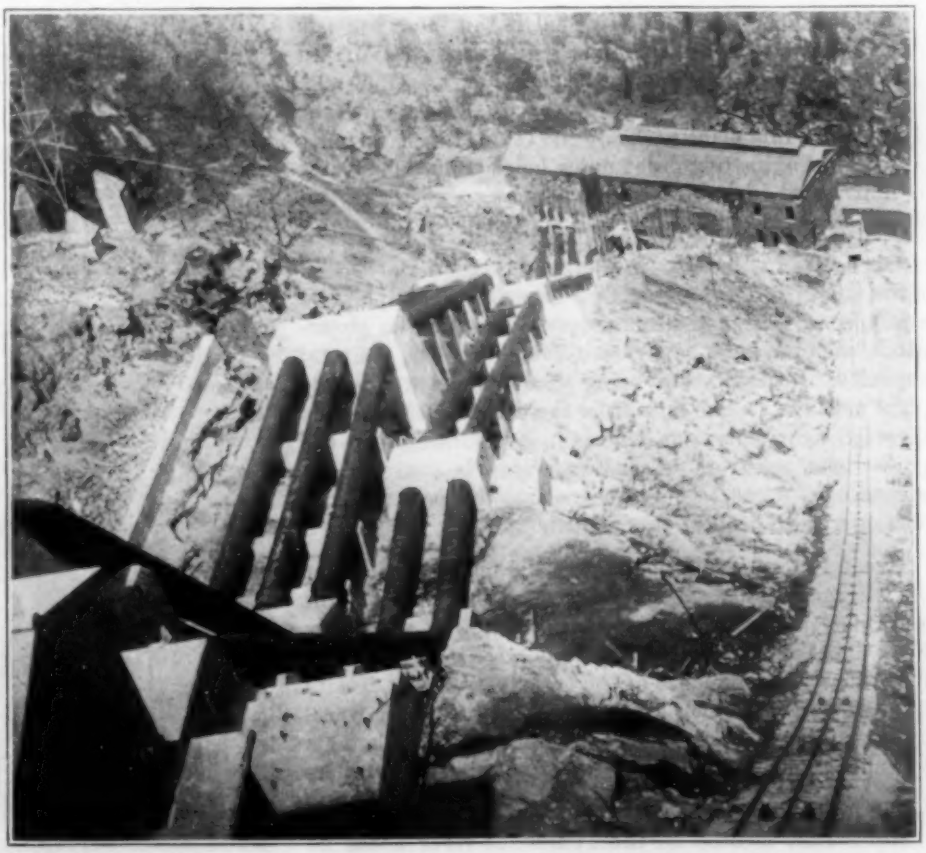
DATA ON SOUTHERN POWER COMPANY'S STATIONS

Location	Maximum Rating	Head, Ft.
Great Falls, S. C.	24,000 Kw.	72
Rocky Creek, S. C.	24,000 Kw.	63
Ninety-nine Islands, S. C.	18,000 Kw.	72
Catawba, S. C.	6,600 Kw.	25
Lookout Shoals, N. C. (under construction)	24,000 Kw.	76
Greenville, S. C. (steam)	8,000 Kw.-a.	..
Greensboro, N. C. (steam)	8,000 Kv.-a.	..
Mount Holly, N. C. (steam)	8,000 Kv.-a.	..

Electricity is generated at 2200, 6600 and 11,000 volts, three-phase, sixty-cycle, there being one 8000-kva, 2300-volt and two 8000-kva, 11,000-volt steam-driven generators, twenty-two 3000-kva, 3000-volt generators, three 7800-kva, 6600-volt generators, four 900-kva, and 750-kva, 11,000-volt generators. The last thirty-three units are of the waterwheel type. There are also connected to the system sixty-five high-voltage transformers having an aggregate rating of 169,400 kva. The lines of the company cover a territory of 300 miles in a northeasterly and southwesterly direction and 100 miles in a northwesterly and southeasterly direction. The first transmission system of the company is designed for 11,000 volts. With the expansion of the company and its activities, a 44,000-volt transmission system was built, and all of the recent transmission lines erected by the company have been designed for 100,000 volts. All lines are looped in together, and the 11,000-volt and 100,000-volt systems are tied together with tie-in transformers. Aluminum and copper are both used for conductors, the size ranging from No. 4 solid copper to No. 000 stranded. By far the greatest amount of the lines are of No. 00 copper stranded and No. 00 equivalent aluminum stranded. This is run on both steel towers and wooden poles with pin-type and suspension-type insulators, depending upon the voltage. There are 103 substations connected to the system, containing 352 transformers with an aggregate rating of 241,162 kva.

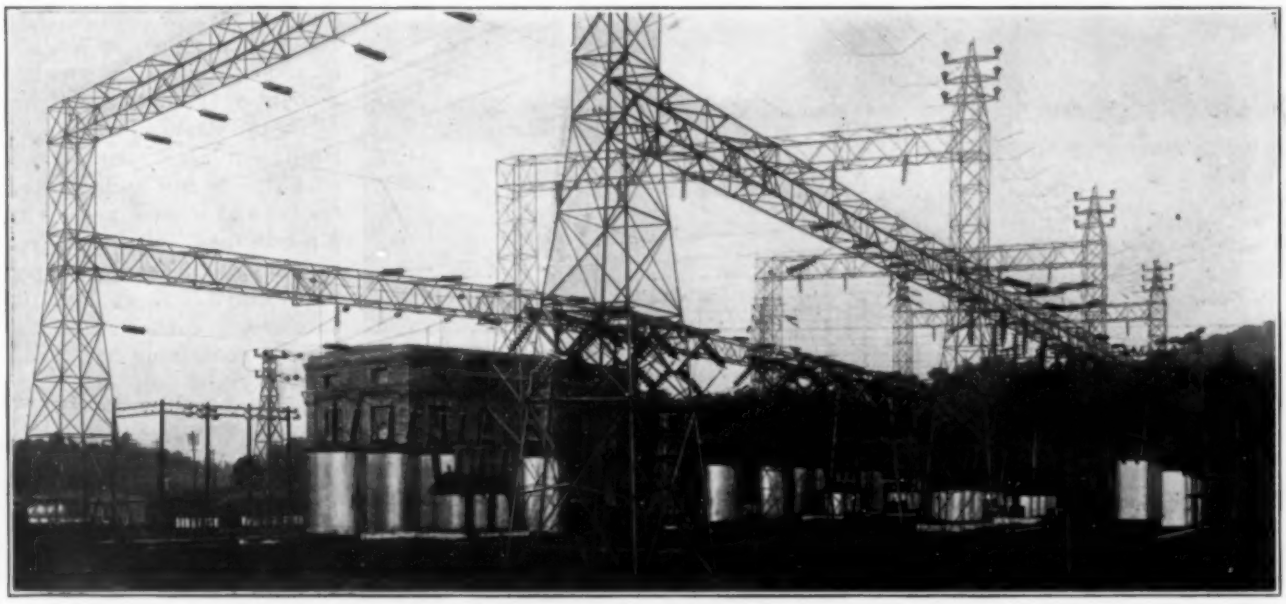
The circuits of the Southern Power Company are connected on the north with those of the Carolina Power & Light Company with two 100,000-volt lines. The amount of power that can be transferred is limited only by the carrying capacity of these lines, as no transformers are required in order to effect this connection. On the south the Southern Power Company's system is connected with that of the Georgia Railway & Power Company at Tallulah Falls, with two 100,000-volt lines, and the power which can be transferred between the two companies at this point is limited only by the carrying capacity of the lines.

It should be pointed out that the rating of the hydroelectric stations of the Southern Power Company is based upon the continuous rating for the continuous amount of twelve-hour power which the station can generate for eight months in the year. The company maintains three 8000-kva. turbo-generator steam plants



PENSTOCKS CONNECTING FOREBAY WITH POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

[3] Ibid.



SUBSTATION—ALABAMA POWER COMPANY, COOSA RIVER HYDROELECTRIC PLANT

for emergency and supplementary service. The fires under the boilers are banked, and all three stations can be got under way to feed energy to the lines within fifteen minutes.

Tennessee Power Co.

The present hydro-electric stations owned and operated by the Tennessee Power Company are as follows:

Ocoee No. 1, located in Polk County at Parksville, Tennessee, on the Ocoee river, approximately 50 miles from Chattanooga. The equipment in this plant consists of five horizontal direct-connected water-wheel-driven generators, each one having a capacity of 3750 kilowatts, the total station capacity being 18,750 kilowatts. The dam at this plant backs up the Ocoee River, forming a lake approximately eight miles long. Sufficient water is impounded to operate the station over a period of two or three weeks during reduced stream flow.

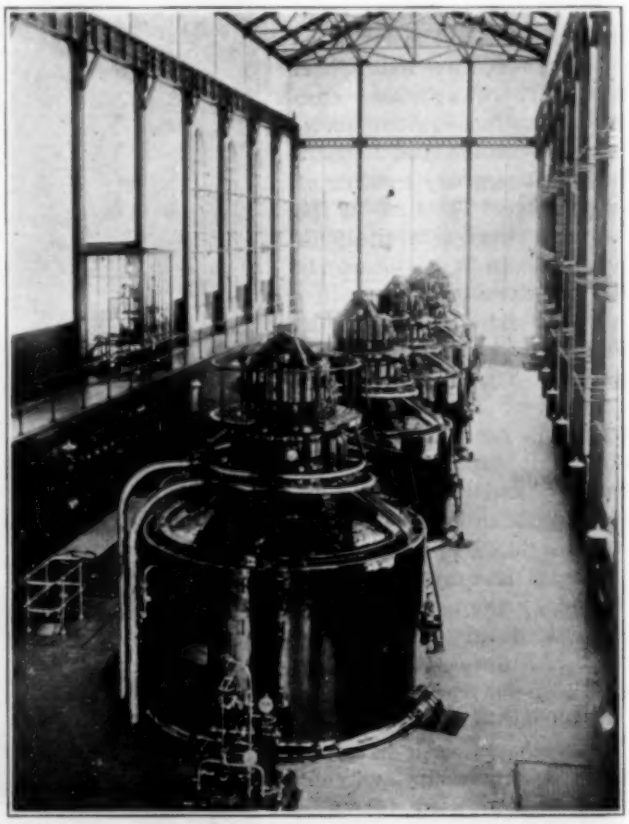
Ocoee No. 2, located in Polk County on the Ocoee river, about ten miles east of Parksville. This plant is equipped with two horizontal water-wheel-driven generators, each having a capacity of 7500 kilowatts, the total capacity of the station being 15,000 kilowatts. This plant uses the stream flow from the Ocoee river, which is diverted by means of a low dam, five miles above the power station, from which the water is conveyed by means of a flume to a forebay above the power house. The operating head at this plant is 255 feet.

Great Falls Station, located at the northwest corner of Warren County, about half way between Nashville and Chattanooga. This plant uses the flow of the Caney Fork and Collins rivers. A low concrete dam is located just below the confluence of the two rivers which diverts the two streams which are conveyed to the water wheel by means of a tunnel and penstock. The plant is equipped with one vertical water-wheel-driven generator, the capacity being 9750 kilowatts.

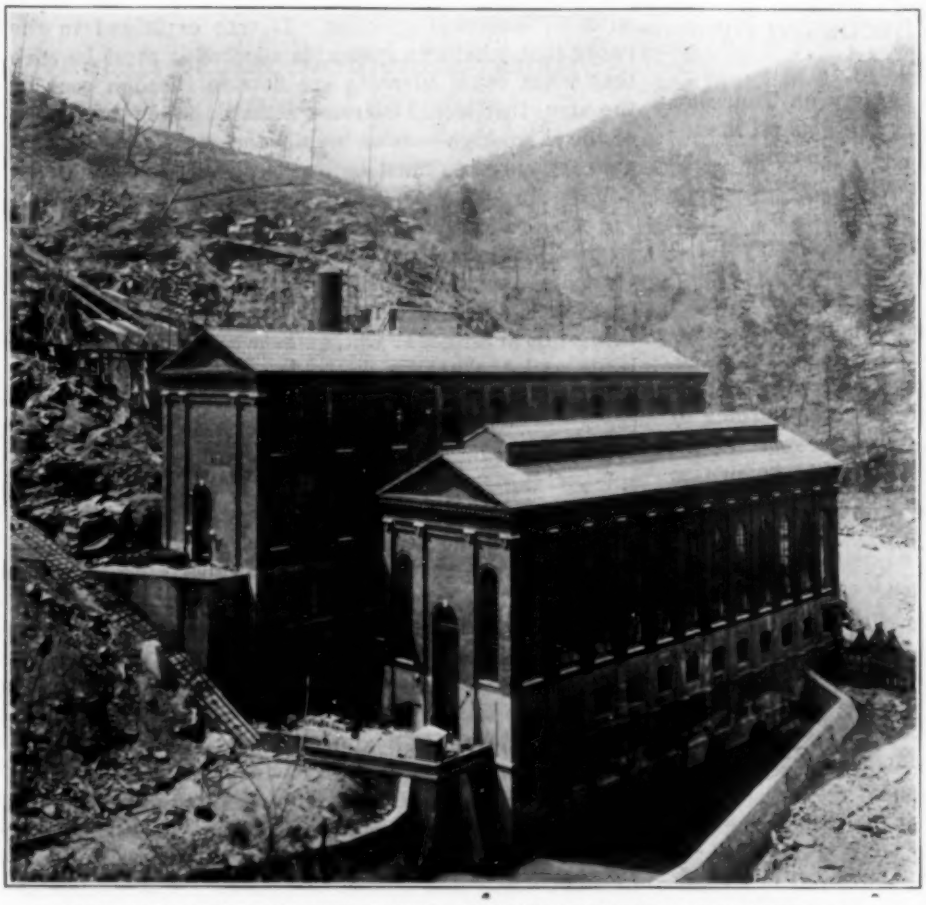
Hales Bar, located on the Tennessee river about 20 miles west of Chattanooga. This plant is equipped with fourteen 3000-kilowatt vertical turbines, the total capacity of the station being 42,000 kilowatts. The concrete dam across the river at the power house site backs up the water and makes the river navigable to Chattanooga. The spillway is 1200 feet long. The dam is provided with a boat-lock which is operated by the government.

The combined capacity of the present hydro-electric stations is 85,000 kilowatts.

Proposed hydro-electric developments: Additional developments have been considered, and rights ob-



GENERATORS, TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.



TALLULAH FALLS POWER HOUSE, GEORGIA RAILWAY AND POWER CO.

tained for three more stations on the Ocoee river, to be known as Ocoee No. 3, Ocoee No. 4 and Ocoee No. 5. The additional capacity from these three stations will be in the neighborhood of 35,000 kilowatts.

Steam Plants: The Tennessee Power Company has an arrangement with the Chattanooga Railway and Light Company, the Nashville Railway and Light Company and the Knoxville Railway and Light Company whereby the steam plants at these three cities may be operated at the direction of the Power Company to supplement the output from the hydro plants during low water. The capacities of the steam stations are as follows:

	Kilowatts
Chattanooga	5,000
Nashville	15,000
Knoxville	4,000
Total	24,000

The Tennessee Power generates the electrical energy used in Chattanooga, Nashville, Knoxville and a large number of the small cities in eastern Tennessee. In addition it supplies power to the Aluminum Company of America at Maryville, Tennessee, 16 miles south of Knoxville, and also to the American Zinc Company at Mascot, Tennessee, 15 miles northeast of Knoxville. The total transmission line mileage is aproximately 600 miles.

The rates for electrical energy are in accordance with the following tabulation:

"A fixed charge of $1.25 per month per kilowatt of maximum demand based on the highest fifteen minute demand during the month, but in no event shall the fixed charge be less than 60% of the total kilowatt capacity contracted for.

"In addition to the above demand charge the following kilowatt hour charge for electrical energy consumed during the month:

	Kilowatt-Hours
4c. per kw.-hr. for the first	500
2c. per kw.-hr. for the next	1,000
1½c. per kw.-hr. for the next	1,500
1c. per kw.-hr. for the next	17,000
0.7c. per kw.-hr. for all over	20,000

"A discount of five (5%) per cent will be allowed upon all bills paid within ten (10) days from their date."

Dyestuff Association Officially Organized.—The Board of Governers of the American Dyestuff Manufacturers' Association met on April 4, at the office of its counsel, Benjamin M. Kaye, 149 Broadway, to elect officers, execute the certificate of incorporation issued by the Secretary of State at Albany, and adopt the constitution and bylaws. The officers elected were: President, Morris R. Poucher of E. I du Pont de Nemours & Co., Wilmington, Del.; First Vice-President, L. A. Ault of Ault & Wilborg, Cincinnati, Ohio; Second Vice-President, Frank Hemingway of Frank Hemingway, Inc., New York; Secretary, C. Cyril Bennett, manager of the Color Trade Journal, New York, and Treasurer, Charles Jenkinson of the National City Bank, New York. Within a short time the association will start an intensive drive in propoganda work in order to acquaint the American public with the enormous strides made in the color industry in this country since the start of the European war. One of the undisguised objects of the new association is to prevent German aggression in the dyestuffs industry in this country after the war. Membership in the organization is open to American manufacturers of dyes and intermediates.

Chemical Trade Specifications.—A definite need which is becoming apparent as our chemical industry expands, is a publication of trade specifications and standards covering those chemical products which are general articles of commerce. This need will become more insistent as new and inexperienced men engage in the buying and selling of chemicals. Their unfamiliarity with trade terms and customs will be fruitful of disagreements unless recognized standards can be freely consulted and made the basis of negotiations. In the hope and expectation of meeting this need Dr. Wallace P. Cohoe of New York, with the coöperation of METALLURGICAL AND CHEMICAL ENGINEERING, has begun the collection of data that will embody a general statement of current trade standards, and which will be published in book form by the McGraw-Hill Book Co. as soon as the compilation can be completed.

Electric Furnaces Discussed by Faraday Society

AT a meeting of the Faraday Society on Thursday, Feb. 14, at Manchester, England, a general discussion took place on electric furnaces. The discussion was presided over by Professor C. A. EDWARDS of the University, Manchester.

The Chairman, in introducing the subject, gave a short account of the history of electric smelting since Siemens in 1878 patented his first small coke electric furnace. In 1904 there were only four electric furnaces in Europe and America; in 1913 there were 114. Development since the war had been phenomenal.

Mr. H. ETCHELLS read a paper on *"Applications of Electric Furnace Methods to Industrial Processes."*

The author referred to the growth of electric furnace industries during the war, which was due not only to the greater output demanded, but to a certain extent because the electric furnace enabled us to use raw materials which were formerly considered inferior for the quality of product desired.

In dividing electric furnaces under the three headings *Induction, Resistance,* and *Arc* types, the author considered that only the latter two types may be looked to for future extensive development. A plea was made for the greater development of the resistance furnace, which from the electric load viewpoint was ideal, giving high load factor, high power factor, and very slight fluctuation. The Bailey furnaces were mentioned as the only furnaces of this type which had hitherto attained an industrial development in large units.

The greatest development of electric furnaces, it was pointed out, had taken place in connection with the steel industry, and especially in regard to the production of special high quality steel castings. In the author's opinion, the electric furnace is not fulfilling its highest function in the foundry when used for simply melting steel scrap to turn out an unrefined product on an acid lining.

The success attained by the Greaves-Etchells furnace in high-speed steels was specially indicated, some Sheffield firms having dispensed with the crucible process and adopted the electric process whole-heartedly.

The unsatisfactory performance of refractory lining materials at present marketed was commented upon, and the author stated it as his belief that satisfactory linings would not be available until electrically fused refractories were put on the market.

Mr. J. BIBBY read a paper on *"Electric Steel Refining Furnaces."* He said the development of the electric furnace for steel making is almost certain to take place in the direction of large furnaces. As furnaces get larger new conditions appear, which require consideration in the design, but economies can be effected in consumption of current, refractory materials and labor. On small furnaces, up to 5 tons' capacity, two electrodes are suffifficient, but on the larger furnaces it is advisable not to concentrate the heating zone in two places, but to distribute it by having four electrodes over a circular bath. Further, on large furnaces large currents are required, and up to the present we only have electrodes which will take currents of, say, 10,000 amp., so that where more than 20,000 amp. are required, more than two electrodes are required for this reason. In the use of four upper electrodes we are confronted with an electrical problem. It was explained in the paper that whatever system is adopted it must be such that when equal currents are flowing through each of the arcs, then equal currents must be taken from each of the three high-tension mains, and each of these three primary currents must be practically in phase with its voltage in order to secure a higher power factor. Further, for metallurgical reasons it is considered desirable that a certain amount of current should flow vertically through the hearth to a fifth fixed electrode beneath it. We therefore require some system which will impress an equal voltage between each upper electrode and the hearth electrode, so that when equally adjusted equal currents, and therefore four equal heating zones, will be obtained.

The condition is met if we can obtain on the furnace side of the transformers four equal phases, one for each electrode, and a common return to a neutral electrode beneath the hearth. In short, we require a four-phase, five-wire system. This can be obtained by simply having two sets of two phases working in parallel, but this system has serious electrical objections. The problem has been satisfactorily solved by the Electro-Metals four-phase arrangement, which consists of three single-phase transformers. Two of these transformers have their terminals connected separately to the four upper electrodes. A tapping is taken from the middle of the third or Teaser transformer to the hearth electrode, and the terminals of the Teaser transformer are connected to intermediate tappings on the main transformers. A closed system is thus obtained when arcs are struck between the four upper electrodes and the bath of metal. This system gives an equal voltage in each of the arcs and therefore equal heating zones, and also when the electrodes are regulated for equal currents, then equal currents are taken from the three primary mains. The average power factor of the system on a non-inductive load is unity. Further advantages of the system are that when the furnace is under poor regulation the primary currents remain tolerably balanced with a high power factor.

A paper on *"Electric Furnace Control"* was presented by Mr. A. P. M. FLEMING and Mr. F. E. HILL.

The methods of control are classified as follows:

I. By Variation of Voltage

(1) Alteration of the ratio of the main transformer by cutting out a portion of the primary winding.

(2) Alteration of the ratio of the main transformer by an auxiliary winding which can be connected up in series with or in opposition to the main winding.

(3) Use of a primary booster transformer to vary the secondary voltage by altering the pressure supplied to the primary.

(4) Use of a secondary booster transformer, the secondary of which is in series with the main secondary, the booster primary being in parallel with the main primary.

(5) Control by means of a motor-generator; a method rarely used.

II. By Variation of Current

Control by this method is accomplished by raising or lowering the electrodes. It may be employed as an auxiliary method to any of those previously described. Examples of both hand regulation and automatic regulation are given in the paper.

Synopsis of Recent Metallurgical and Chemical Literature

Comparison of High-Temperature Scales.— E. P. HYDE and W. E. FORSYTHE of the Nela Research Laboratory presented a paper at the Rochester meeting of the American Physical Society giving the final results of a study on the above subject, and which present a very clear idea of the relative accuracy with which carefully made temperature determinations can be compared. The intercomparison of the temperature scales of the Bureau of Standards, the Physical Laboratory of the University of Wisconsin, the Research Laboratory of the General Electric Company at Schenectady, and the Nela Research Laboratory was carried out through measurements made on several tungsten-filament lamps, the exact point at which it was desired to have the temperature measured being indicated either by a pointer, a notch on the supporting lead, or a small notch on the filament itself. High-temperature scales are for the most part based on the temperatures of standard melting points for the most part obtained inside a standard black-body furnace and extended beyond these points by means of radiation laws. All the above laboratories (except the University of Wisconsin, which used palladium at 1822 deg. K.) base their temperature scale on the melting point of gold (1336 deg. K.) and extrapolate by means of Wien's equation using for C_2 14350 $\mu \times$ deg. There are three sources of error: (1) in obtaining the temperature of the melting point, (2) in the blackness of the furnace used, and (3) in the extrapolation, and the combination might well lead to large uncertainties in the final result. The results in deg. K. are given in the following table, in part, reduced to the melting point of palladium. As the red-glass screen used in the different laboratories varied somewhat, it was necessary to reduce the temperatures to the same wave length (0.665μ). Holborn-Kurlbaum pyrometers were used.

Lamp No.	T-16-B	T-30-C	T-17-C	T-18-B
Nela	1618	2756		
Schenectady	1613	2752		
Nela	1617	2752		
Bureau Standards	1619	2762		
Nela	1614	2752	2499	2105
Wisconsin			2511	2121
Nela			2497	2107

Furnace Control by Optical Pyrometers.—The making of optical glass is strictly dependent upon the furnace temperatures, as noted by C. N. FENNER of the Geophysical Laboratory (The Physical Review, Vol. XI, p 141.) If the temperature of melting and fining is a little lower than supposed the resulting glass will be full of bubbles, or even milky. On the other hand, too high temperatures will corrode even the best melting pots, contributing stones to the melt, sometimes corroding through. These important considerations limit the operations to a temperature range between 1300 and 1400 deg. C. The furnaces in the Bausch and Lomb plant had been equipped with platinum thermocouples, but rapid contamination by furnace gases caused unsatisfactory service. A Morse instrument has been substituted with excellent results, the furnace men being easily educated to its use. Previously to making the change it was found that the calibration chart furnished by the makers was correct at all points to within a very few degrees or the limit of error. A more important test was whether the furnace walls radiated as a black body. This was investigated by means of a platinum thermocouple contained in a Marquardt porcelain tube fixed in the end of a water-cooled iron pipe extension, through which the lead wires extended. By using this simultaneously with the optical pyrometer, the temperatures of the walls as observed by optical and thermo-electric were almost identical. At temperatures lower than 1300, however, the optical readings were high, owing to the error caused by the reflection of the flames from the glazed walls.

Ferrous Metallurgy in Canada.—DR. ALFRED STANSFIELD, in a paper on "Recent Advances in Canadian Metallurgy" before the March meeting of the Canadian Society of Civil Engineers notes that a recent study of the Lake St. John (Quebec) District has caused him to modify his opinion expressed after a study of the Swedish industry just prior to the war that it would not be profitable to produce electric pig iron in Canada, since at Lake St. John a high-grade white iron containing titanium appears to be a desirable possibility. The Canadian production of electric steel has increased from 61 tons in 1914 to approximately 50,000 tons in 1917, mostly as shell billets from steel scrap. Several furnaces are in operation in and about Montreal, the Munitions Board has built ten 6-ton furnaces at Toronto, and the Armstrong Whitworth Company has built a plant for the production of electric tool steel at Longueuil. While the furnace at Belleville has made much good steel from titaniferous ore, it has been found cheaper to use scrap. This furnace and another at Orilla has recently been fully occupied with the production of ferro-molybdenum. Before the war from eight to ten thousand tons of ferro alloys, mostly ferro-silicon, were made annually at Welland by the Electro-Metals, Ltd. This alloy is now made also at Shawinigan. In 1916 the production of ferro alloys had increased to 28,600 tons, valued at $1,777,000, and included a large tonnage of ferro-phosphorus made at Buckingham, P. Q., by the Electric Reduction Company.

The Electrodeposition of Zinc.—In a paper to be presented at the fall meeting of the American Institute of Mining Engineers, C. A. HANSEN, of the General Electric Company, gives some important information on the proper practice in electrolytic zinc. He postulates two major reactions in the cell: first, zinc deposition at the cathode according to Faraday's constant, and second, corrosion of this zinc by the solutions according to the surface exposed and the chemical activity of the solution as mainly determined by its acidity. He also discusses the meager data on the effect of temperature on the deposition, showing a reduced current efficiency in pure solutions at higher temperatures, and he shows that its bad effect may be obviated by (a) flushing out the unsatisfactory solution, (b) cutting down the cell current, reducing the acid concentration and therefore the corrosion, as well as the energy input, and (c) using glue, lanolin, and other organic reagents whose effect,

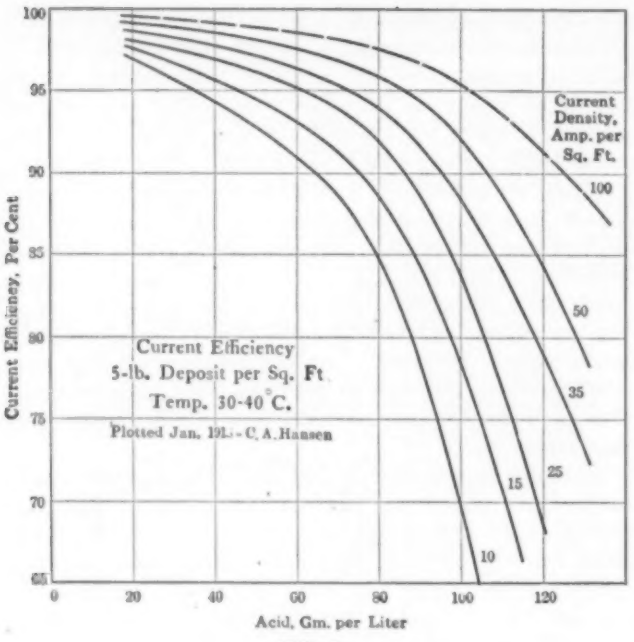


FIG. 1.

though beneficial, is cursory. According to the author's postulates, the difference between 100 per cent current efficiency and the actual is a measure of the corrosion rate. Since the latter increases with the current density (high current densities yield rougher deposits, particularly with low acid concentrations), this conclusion agrees qualitatively with facts. Values from the curves, Figure 1, do not agree as well with observed results as expected, and a second variable is thought to be the lack of zinc which exists in high acid solutions. The voltage data of Figure 2 were determined in a special cell so constructed as to avoid the errors of small cells, and include contact and other losses. Direct current data for the electrolysis

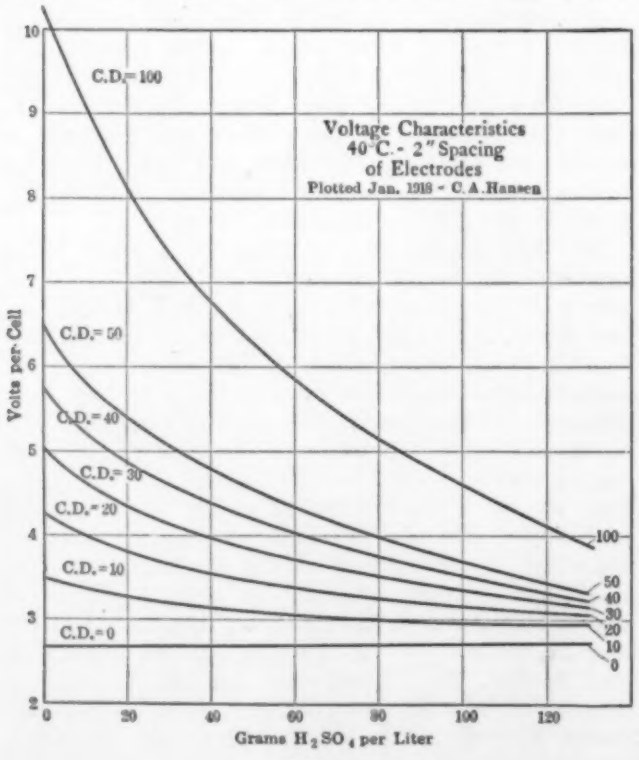


FIG. 2.

of pure zinc sulphate solutions should be multiplied by the factor 1.145 or 1.21 depending upon the electrical conversion apparatus in use. The cost of the cell room is almost inversely proportional to the current density. High leach-tank temperatures which are desirable are largely had by low current efficiency, which is undesirable.

Non-cumulative impurities in the electrolyte are copper, cadmium, arsenic, antimony, iron, manganese, silica and alumina. Copper and cadmium are precipitated with zinc, and will come down in the early cells

Cu or Cd, milligrams per liter	0	5	10
Acid, 30 gm. per liter	99	93	90
Acid, 60 gm. per liter	96	87	81
Acid, 90 gm. per liter	93	76	65

of a cascade, in which the current efficiency will no longer correspond to that expected for pure solutions.

Arsenic and antimony are not precipitated, but remain in the effluent. They are less dangerous in manganese-free electrolytes; with manganese a variation from 0.0003 to 0.001 gram antimony per liter made the difference between excellent and impossible cell-room practice.

The behavior of iron is less consistent, but it evidently serves no good purpose. Manganese by itself exerts no harm. The sulphate is oxidized in part to permanganic acid at the anode, reacting with the sul-

Acid, Grams per Liter	Arsenic, Milligrams per Liter			Antimony, Milligrams per Liter		
	0	5	10	0	5	10
30	99	94	90	99	91	84
60	96	83	77	96	80	65
90	93	66	50	93	63	35

phate and throwing out manganese dioxide at the surface of the anode itself. This dioxide adheres with low acid concentration, with higher it drops as a slime always containing substantially the same amount of lead peroxide.

Some cumulative impurities are unimportant; such are the alkali metals and magnesium. Others, such as nickel, cobalt, vanadium and possibly uranium affect the cells when in such small amounts that chemical analysis can hardly detect them. The behavior of the cell itself is thus the surest check on the thoroughness of the purification. The effect of cobalt is shown by the following table:

Co, Milligrams per Liter	0	5	10	15	20
Acid, 30 gm. per liter	99	96	93	91	87
Acid, 60 gm. per liter	96	90	85	77	64
Acid, 90 gm. per liter	93	80	70	55	30

Pure solutions invariably yield excellent deposits, wholly without blemish on the starting sheet side. Pinholes are almost always found when impurities in quantity of tenths of milligrams per liter are present. If serious quantities are present, a good deposit may form for some hours, and then start corroding at such a rate that it entirely disappears, only to be redeposited later. It is the realization that thorough purification is a necessity which has made the process commercial. In spite of the effort spent on synthetic solutions, no inorganic addition agent has been found which improves the power characteristics of the cell, or affects the product other than forming a slightly smoother deposit.

Temperature Sensitive Paints.—In the *General Electric Review* for February, W. S. ANDREWS gives some condensed data on temperature sensitive paints. He says this term has been applied to chemical compounds that are subject to color changes at a comparatively small rise in temperature. These paints are occasionally used for indicating a dangerous rise in the temperature of machine bearings, electric generators and other apparatus where excessive heating has to be avoided. The two compounds described are easy to make and reliable in operation. The double iodide of mercury and copper is normally red but turns black at about 87 deg. C., becoming red again when the temperature falls. To prepare it make separate solutions of copper sulphate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the precipitate which is first formed is re-dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate) and the red double iodide of mercury and copper will be precipitated. Wash and dry this precipitate on filter paper. The red powder may be mixed with a weak solution of gum arabic in water and used as a paint. The double iodide of mercury and silver is normally of a light primrose yellow, but turns to a dark orange or brick red at about 45 deg. C. It becomes yellow again on cooling—and it may be heated and cooled an unlimited number of times without losing its curious property, providing it is not overheated. To prepare it make separate solutions of silver nitrate and potassium iodide in distilled water. Add the latter to the former with constant stirring until the original precipitate is dissolved. Then add a strong solution of mercuric chloride (corrosive sublimate), which will produce a precipitate of the double iodide of mercury and silver of a bright yellow color. Wash and dry the precipitate on filter paper. It can be used as a paint by mixing with a weak solution of gum arabic in water.

Recent Metallurgical and Chemical Patents

Wood Distillation

Distilling Pyroligneous Acid.—H. O. V. BERGSTRÖM, of Stockholm, Sweden, patents a process of distilling pyroligneous acid under pressure. In the dry distillation of wood or other substance containing cellulose, so-called pyroligneous acid is obtained which principally contains water, acetic acid, wood spirit and tar or tarry constituents dissolved in the pyroligneous acid. The acetic acid is generally recovered in the form of acetate of lime and in order to obtain an acetate containing a high percentage of Ca $(OCOCH_3)_2$ the pyroligneous acid is preferably distilled and the distillate is saturated with lime and evaporated. The present invention refers to a method of distilling pyroligneous acid which utilizes the distillation vapors. The charactertistic feature consists in executing the whole process under superatmospheric pressure in the system of apparatus. Consequently, the distillation of the pyroligneous acid is performed under an increased pressure, say 2–4 atmospheres, in the distillation boiler, the vapors formed during the distillation are led also under an increased pressure into lime white or other substance adapted for binding the acid constituents of the same, and the resulting vapors are also held under an increased pressure when utilized for heating purposes, for example for distilling pyroligneous acid, for depriving the same of spirit, for drying the acetate obtained, etc. Another feature of the invention consists in passing the vapors from the distillation of the pyroligneous acid through liquid pyroligneous acid (crude or deprived of spirit) before being led into the lime white or other substance adapted for binding the acid constituents of the same. By this means the tar or tarry constituents are removed from the vapors before they are led into the lime white and a purer acetate is formed.

Another feature of the invention consists in that the vapors, washed with pyroligneous acid or not, instead of being directly led into lime white or the like, are led into a heating element surrounded by acetate solution or other liquid which is to be concentrated. The vapors are condensed in said heating element and the condensate is then saturated with lime or other base for forming acetate solution. In passing through the heating element the vapors give off their heat to the solution, or liquid surrounding the same, the solution being thereby brought to boiling and is, thus, concentrated. The vapors escaping from the boiling solution or liquid may still be maintained under an increased pressure and be utilized for heating purposes as stated above. Another feature consists in using acetate solution instead of water for slaking the lime in order to obtain the lime white necessary for neutralizing the acid constituents of the vapors either in the state of vapors or after having been condensed. (1,261,344 Apr. 2, 1918.)

Dyes and Intermediates

Vat Dyestuffs.—M. P. SCHMIDT, of Biebrich-on-the-Rhine, Germany, patents a process for the manufacture of vat dyestuffs of the carbazole naphtho quinone series. He has found that the carbazole-naphtho-quinones derived from alpha- or beta- naphthylamine still present a similar capacity of condensation as the simple quinones themselves. They give valuable vat dyestuffs of a brown to black tint with the usual compounds containing reactive hydrogen-atoms. Amins, sulphinic-acids, oxythionaphthene, indoxyl or their derivatives and in general all compounds containing reactive hydrogen atoms are suitable for the condensation. It seems that the condensation takes place in the same manner as with naphthoquinones, the element connected with the reactive hydrogen atoms going in orthoposition to one of the quinone-oxygen-atoms, whereby leuco-compounds are produced in the first place with change or may be converted into vat dyestuffs, either by the action of the oxygen of the air or by the employment of other means of oxidation.

They are reddish-brown powders, difficultly soluble in the usual solvents. They may be crystallized from hot glacial acetic acid. With alkaline hydrosulphite they give a yellow vat, from which wool is dyed brown.

24.7 parts of the quinone obtainable from the 1.2-pheno-5-oxynaphthocarbazole are suspended in about 250 parts of water, and 15.6 parts of toluene sulphinic acid are added. The mass is acidified with some hydrochloric acid and heated and stirred on the water-bath for some hours. It is then made alkaline and air is blown through it, until the dyestuff is fully oxidized. The precipitate of a brown color is drained off and washed with water.

The dyestuff yields with alkaline reducing agents a yellow vat, from which wool is dyed with fast brown tints. (1,261,858, Apr. 9, 1918.)

Vat Dyestuffs.—MICHAEL ILJINSKY of Uerdingen-on-the-Rhine, Germany, patents a process of making vat dyes. The invention relates to vat-dyestuffs containing sulphur with an anthraquinone molecule, which are obtained by dry heating of anthraquinone or anthraquinone derivatives with thiosulphates. If for example anthraquinone-sulphonic acids or their salts are heated with thiosulphates, products which can easily be vatted and which take upon cotton in powerful fast tones are formed, while sulphur is liberated. The products of the process mentioned in German Patent 95484 are black sulphur dyestuffs and they are dyed from sodium sulphide solution. The products of the present invention are insoluble in sodium sulphide solution, they are dyed from alkaline hydrosulphite vats and they give olive-colored tints. Also the products resulting from the process described in German Patent 226879 (Example 3) are not identical with those of the present invention. Apart from the difference in color, the dyestuffs prepared according to that specification are all soluble in concentrated sulphuric acid, whereas the new products are insoluble in concentrated sulphuric acid. For the preparation of sulphur dyestuffs, thiosulphates have heretofore many times been employed, but hitherto always in aqueous solutions and with addition of alkali. The present process on the contrary proceeds in the absence of water and alkali, the reacting mixture remaining dry during the whole process. Such thiosulphate melts (if "melts" may in this case be spoken of at all) have not previously been produced. The specification states that it is surprising that under such circumstances the substances enter into reaction. Comparative experiments have demonstrated that for example a mixture of dry sodium anthroquinone-sulphonate, sulphate and sulphur, does not react in a similar manner under the same circumstances. (1,261,394, Apr. 2, 1918.)

Phthalic Anhydride.—THOMAS D. GREENLEY of Glen Ridge, N. J., patents a process of making phthalic anhydride which he assigns to the Ellis-Foster Co., of New Jersey. The process is described as follows:

The first step in the operation is to prepare as an activator or accelerator of reaction a quantity of sulphate of mercury which may be produced by heating and stirring 10 lb. of mercury with 100 lb. of oleum containing 20 per cent SO_3, the temperature being raised to 200 deg. C. and maintained at that point with constant agitation for a period of about one hour. If mercury sulphate is available from other sources or from a preceding run, it is not necessary to prepare the sulphate in this manner. 30 lb. of naphthalene are dissolved in 100 lb. of oleum of the same strength as the foregoing and this solution or mixture is added to the mercury sulphate in acid solution prepared as above set forth. The mixture is heated in a retort to 250 deg. C. and is maintained at this temperature until about one-half of the reaction mass has distilled over. During this heating and distilling operation the reaction mass may be well agitated and to this end the retort is equipped with a stirring device which may be operated so as to give a mild to vigorous agitation, depending upon the size and shape of retort and conditions of operation. In any event, preferably the agitation is carried out in such a manner as to secure a satisfactory intermingling of the reacting constituents. The mass is then cooled to about 200 deg. C. and 100 lb. of oleum are added. The temperature is then raised to about 250 deg., the other conditions being the same as the foregoing. After distillation has been completed to about one-half the volume of the reaction mass, 150 lb. of oleum are added and the temperature carefully raised to about 300 deg. C. The distillate may then be filtered, treated with caustic soda solution and again filtered, the alkaline solution neutralized and evaporated to dryness. To purify, the mass is heated to the subliming point of phthalic anhydride the product is suitably collected and may be purified as desired. (1,261,022, Apr. 2, 1918.)

Refractories

Bonding Kieselguhr Powder.—CHARLES S. KINNISON of Birmingham, England, proposes to bond Kieselguhr so that it may be molded into any desired shape by adding soda-ash solution and drying. Best results are obtained by using 8 to 15 per cent of soda ash and 92 to 85 per cent of Kieselguhr. It is thought that sodium silicate is formed in the drying process. (1,259,525; Mar. 19, 1918.)

Potash

Potash from Kelp.—FRANK K. CAMERON of Salt Lake City, Utah, patents a process of obtaining potash salts from kelp, which he assigns to the Alaska Products Co., of New York. The process comprises mincing and straining the kelp in such a manner as to produce thorough aeration, adding an acid flucculating agent (hydrochloric acid) to produce a floating separation of coagulum from the clear liquor, returning the floating coagulum for treatment together with fresh kelp in the straining operation and evaporating the liquor to crystallization. (1,259,486; Mar. 19, 1918.)

Potash from Leucite Rock.—FRANZ A. RODY of Newark, N. J., patents a process of obtaining potash from silicate rock and other silicates such as leucite, feldspar, etc. The patent is assigned to the Metallurgical Co. of America, of New York. The method comprises fusing about one hundred parts of crude leucite, reducing it to a powder of one hundred mesh and then digesting for about an hour with water and about six parts of lime at a pressure of one hundred pounds per square inch, thereby bringing the alkalis into solution. (1,260,944; Mar. 26, 1918.)

Explosives

Nitro Compounds from Tar Oils.—JOHN R. MARDICK of New York, patents a process of making nitro-compounds from tar oil raw materials containing

several per cent of compounds removable by crystallization and repeated washings, not exceeding three, with 2½ to 5 per cent by weight of sulphuric acid and 5 per cent solution of soda ash, (1) coal tar distillate having a sp.gr. from 1.00 to 1.10 (2) impure water-gas tar distillate having a sp.gr. of 0.95 to 1.08; (3) producer-gas tar distillate having a sp.gr. of 0.95 to 1.08; (4) the first two-thirds of the entire distillate of coal tar; (5) the distillate of a tar or mixture of tar distillates having a sp.gr. between 0.95 to 1.10. The following special nitration process is used as distinguished from the processes customarily employed for nitrating pure benzol, toluol, etc. In operating for example upon coal-tar distillate having a sp.gr. of 1.00 to 1.10 one and one-half parts of an acid mixture consisting of 45 per cent HNO_3, 38 per cent H_2SO_4 and 17 per cent H_2O is used, the acid mixture having a sp.gr. of 1.54 to one part of the aforesaid material, the same being mixed by the gradual addition of the said acid to the oil over a prolonged period of time, preferably about 7 to 8 hours and the temperature of the nitration bath being maintained by means of constant stirring and cooling, during the first two hours between 25 to 30 deg. C., the next three hours between 30 and 35 deg. C. and the last two hours between 35 and 40 deg. C. with the extreme limit preferably 45 deg. C. and in no case above 60 deg. C. After the nitration has been completed, the acid bath beneath the nitro-compounds is withdrawn in the manner customary in the manufacture of tri-nitro-toluene and nitro-glycerin, and the nitro-compound is then drowned in water in the well-known manner by throwing the same into a large volume of water and then thoroughly washing the resultant nitro-product in a suitable vessel with the water maintained at a temperature of about 40 deg. C. The washing operation is preferably repeated about three times. After the washing the nitro-compound obtained is removed to a kneading machine and washed with several changes of water, about three, or until the water shows no substantial acid reaction. Then a small amount of magnesium carbonate is added to neutralize the acid and the material is thoroughly agitated, whereupon it is again washed with water and any soluble crystalline salts are washed out. (1,258,587; Mar. 5, 1918.)

Electrolytic Zinc

Electrolytic Process.—HERBERT R. HANLEY, of Winthrop, Calif., (assigned to Bully Hill Copper Mining and Smelting Co.) patents a zinc extraction process to increase the amount of water-soluble zinc compounds by an acid roast, to remove impurities, and to produce sulphuric acid as a by-product. Sulphide ores should be first roasted to give the maximum amount of sulphates, then this calcine, oxidized zinc ore or fume is mixed with 50 per cent sulphuric acid to form a thick mud (approximately 30 pounds of acid per hundred of ore). The mixture is air dried, then for twelve hours in a flue drier, when the cake is broken to ½ inch and roasted at temperatures ranging from 260 deg. C. at the cold end (200 deg. C. minimum) to 500 deg. C. at the hot end (650 deg. maximum) converting substantially all zinc compounds into water-soluble sulphates, and volatalizing arsenic and selenium. The hot calcine is agitated with water to produce a solution of 1.27 specific gravity and purified in the usual way. An electrolyte preferably containing 120 grams zinc sulphate per liter is then deposited with air agitation until the zinc has fallen to the lowest percentage practicable considering the expense of the current used. The spent electrolyte now contains alkaline and zinc sulphates as well as sulphuric acid and is evaporated to the concentration necessary so it may be added to the beginning of a new cycle. In this process the bulk of the magnesium sulphate will crystalize out, together with a quantity of alkaline sulphates depending upon the amount of zinc remaining in the solution. This sulphate radicle lost is supplied in the primary roast—it may even be necessary to continuously remove an excess of acid so formed. (1,241,966, Oct. 2, 1917.)

Aerating Anode.—Mr. Hanley also patents an aerating device serving also as an anode, illustrated in Fig. 1. The aluminium cathode 2 is suspended between

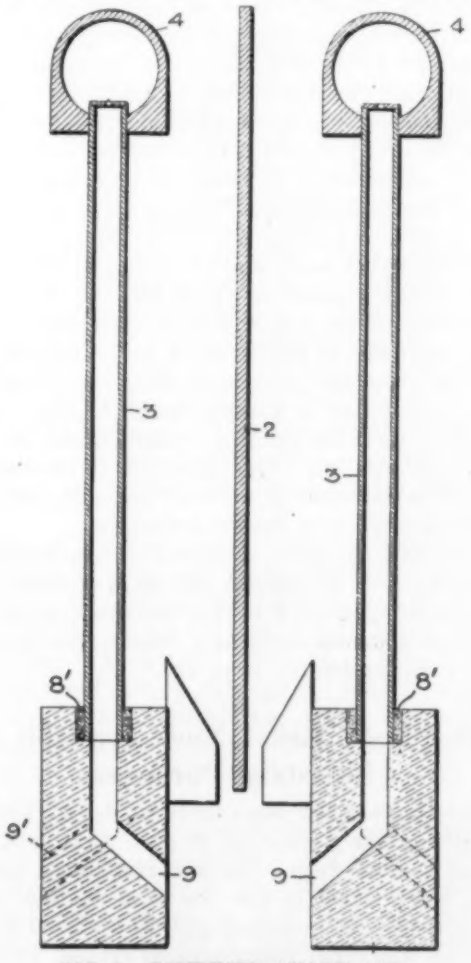


FIG. 1. COMBINED ANODE AND AERATING DEVICE

a series of lead pipes 3 acting as insoluble anodes. The pipes receive an air supply from a manifold 4 placed above the solution and discharge it at reduced pressure to alternate sides of a nonconducting base 8 fixed across the tank, through openings 9 so large as not to be plugged up by crystals or slimes. The air bubbling up along the face of the cathode brushes off the polarizing hydrogen film, and thus increases the current efficiency. (1,241,967, Oct. 2, 1917.)

Electrodeposition in Strongly Acid Solutions.—U. C. TAINTON and J. N. PRING of England have formerly patented a process (No. 1,059,233) consisting of adding to the zinc solution to be electrolyzed a large percentage of acid and a small proportion of a colloid, and electrolyzing with a current of high density. They now find that some of the advantages of this process can be secured without the colloid, if conditions do not require a smooth and lustrous deposit. A saturated solution of zinc sulphate, for instance, to which was added 16 per cent of sulphuric acid was electrolyzed at a current density of 600 amperes per square foot, obtaining firm deposits with a current efficiency of 94.6 per cent. (1,247,179, Nov. 20, 1917.)

A New Method of Extinguishing Chemical and Oil Fires

The problem of protecting gasoline, oils, chemicals and other inflammable liquids from fire has always been a pressing one. Recently a method of attacking this problem has been devised, which consists in covering the burning surface with "firefoam," which is essentially a carbon dioxide foam very light in specific gravity which floats on the burning surface and snuffs the fire out.

As is generally known it is useless to attempt to extinguish oil, gasoline or chemical fires with water or ordinary fire extinguishers. Water sinks to the bottom of the liquids, or putting it in other words, the burning liquids float on the water and the fire is not extinguished. If extinguishing gases are used they are blown away by the draft of the fire and very little good is accomplished, especially if the fire is of any great magnitude.

This new method of extinguishing fires confines the carbon dioxide gas in a thick, tough blanket of foam, which floats upon the lightest liquids, cutting off the air supply from the fire. The substance is claimed to be quite permanent, lasting an hour or more, which prevents the possibility of the fire reflashing.

The product has been developed by the Erwin Manufacturing Co. of Milwaukee, who have designed special apparatus for applying it so that tanks even 40 or 50 feet or larger in diameter containing inflammable liquids can now be given protection from fire.

Pure Sheet Nickel Now Available for Industrial Purposes

During the past few years there has been a great deal of activity in the promotion of pure nickel and nickel alloys in various forms for manufacturing purposes.

Pure, solid nickel is not the same as the inferior metals usually sold as nickel, such as are used in nickel watch-cases and other manufactured articles which consist mostly of steel, brass or German silver with a thin plating of nickel. This plating wears off in a short time. Pure nickel does not rust or oxidize; it will not tarnish like silver or some of the alloys, such as German silver, and there is no danger of corrosion resulting in the surface being injured as with a plated material. It is not attacked by acids or alkalies in the dilute form, like copper and its alloys, and is practically immune to the attacks of all alkalies regardless of their strength, and is largely resistant to the action of most acids. Nickel also has a very high tensile strength, which is among its chief advantages when used as an acid resisting metal, as there are very few of the other metals which will resist these corroding elements and at the same time have sufficient strength to fit them for many purposes in the chemical field. Pure nickel, when manufactured in the form of sheets, being homogeneous, in addition to its great tensile strength, is very ductile and easily formed by spinning or stamping. Specially formed articles for use in manufacturing chemical equipment can be manufactured from nickel without using any special equipment except that as employed in manufacturing articles from German silver or other hard alloys. Pure nickel tubing is being manufactured and can be supplied in quantities and in all the commercial sizes.

The increase in the cost of copper and its products has brought this to a point where pure nickel can be compared favorably with it as to initial cost. The service and long life of nickel cannot be compared with the common metals.

There are many uses for this metal in the chemical field. Many parts of chemical apparatus require a metal which will withstand the action of corroding elements without deterioration. Facilities for manufacturing pure sheet nickel have been provided for by the Driver-Harris Company, of Harrison, N. J., and for the manufacture of tubing, by the Newark Tube & Metal Works, Newark, N. J.

Handling Ashes with Electric Hoists

The problem of handling ashes mechanically is becoming more urgent, and a mono-rail electric hoist with a bottom dumping bucket has been developed by the Link-Belt Company of Philadelphia, Pa., for this purpose. A photograph of this hoist, in use at the plant of

MONO-RAIL HOIST FOR ASH HANDLING

the Philadelphia Paper Company, is shown in the accompanying drawing.

This machine runs on the lower flange of an I-beam track. It is operated by a man traveling in a trailer cage, who controls the raising or lowering of the bucket, as well as the travel of the hoist. About thirty tons of ashes are handled daily at this plant and are pulled out every six hours.

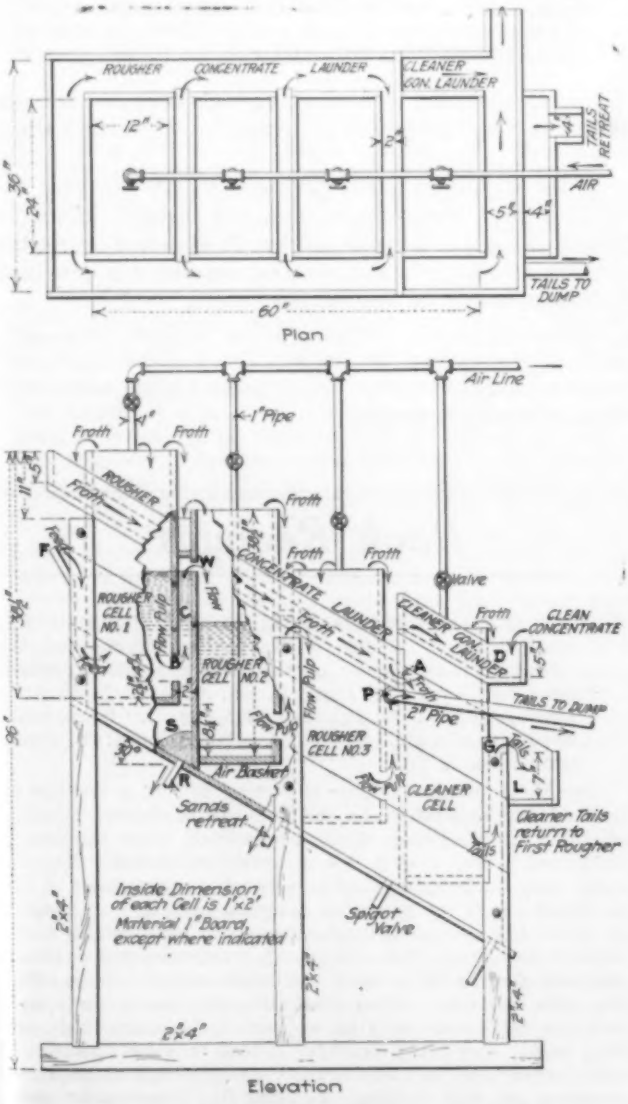
A New Flotation Machine

By A. W. Fahrenwald

THE flotation machine shown in the accompanying illustrations was designed by me for the Texas State School of Mines, to be installed in the testing mill now under construction. To conform with the capacity of the rest of the mill it is designed to treat from 300 to 400 lb. per hr.

The apparatus as shown in the two views consists, in the main, of four cells identical in shape and size. The first three are for roughing and the fourth one for cleaning the concentrates from these. The cells are inclined at an angle of 30 deg. with the horizontal giving a drop of 9½ in. from cell to cell. This drop gives a gravity flow to the pulp in passing through the machine. The distance between cells is 2 in. for this testing machine. For larger capacity in mill work this would be increased somewhat. For large capacity the length of each cell would also be increased to 2½ ft. and the width to 8 to 10 ft. depending upon the tonnage required. The machine is self-contained, which is convenient for testing work. It is easy to operate and requires little attention.

Following the passage of pulp through the machine, the feed enters at the point F, and thence into the rougher cell No. 1. Here the pulp is subjected to the usual pneumatic action where a concentrate froth is formed; this builds up and flows over the four sides of the cell as indicated by the arrows, into a launder which serves the three roughing cells. From roughing cell No. 1 the pulp passes under the baffle B and up the rectangular channel C, between the first and second roughing cells, into roughing cell No. 2. The opening in roughing cell No. 2 controls the height of pulp level in cell No. 1. A similar opening in cell No. 3 controls the pulp level in cell No. 2 and so on through any number of cells. A pipe P for discharging tailings, controls the pulp level in the last roughing cell. The froth overflow from the three roughing cells passes down a common launder into the cleaner cell through the opening A. In this cell a clean concentrate is produced and a tailing overflow at G which is returned to the first roughing cell.



FAHRENWALD FLOTATION MACHINE

The arrangement of cells described is not limited to three cells in series, but three would ordinarily be sufficient. The capacity of the machine can be varied from a very small amount up to the maximum at which point some flotable sulphide would be discharged with the tailings. The operation of the machine is simple and does not require any great amount of care. The only adjustment necessary is that of the air which is accomplished by the use of one main valve. The gate W can also be made adjustable.

In this machine it is possible to treat a feed containing sands. Particles that are too heavy to be carried up the channel C, by the uprising current of pulp, settle down into the pocket S where they can be removed intermittently or continuously through the spigot valve R. For a feed containing sands the first cell would act as a classifier, the sands being sent back to the grinding machine. This opening also affords a way of cleaning out the machine after each test.

The form of bottom used for injecting air into the pulp consists of a top and bottom ribbed casting between which is clamped four thicknesses of canvas. A projection passes up through a hole in the center, connected to a ¾ in. air line. The air is forced underneath the canvas and up through it. There is no leak through the hole in the canvas which fits over the projection since it is clamped between the bottom and top pieces by four bolts at the center in the same way as at the edges.

The machine for testing purposes is self contained; the height of pulp level in each cell is controlled by an opening in the side of the succeeding cell; the froth formed over flows on four sides of each cell, thus giving each particle of concentrate a minimum distance to travel in leaving the machine; the porous bottoms for injecting air into the pulp are lowered into the cells from above and the removal of one for repair does not interfere with the operation of the other cells; it is simple in construction and of low first cost, the pulp passes over a weir the entire width of the machine which gives the individual particles a better chance to be floated than if the same mass of pulp entered the cell through a pipe which overloads the machine in that immediate vicinity.

El Paso, Texas.

Automatic Electric Furnace Control

WITH the advent during the past year of 20-ton electric furnaces and indications of an advance to a standard maximum of 30 tons, the General Electric Company developed an improved system of automatic control to handle the motive power necessitated.

These improvements became necessary as the rate of steel production in these furnaces had been increased by the use of higher capacity transformers and higher voltages, which permitted forcing power into the furnaces at considerably higher rates.

The control panel is made in three sections, as shown in Fig. 1. The top section contains three shunt relays and three contractor groups; the total number of each being in accordance with the number of electrodes used. The middle section has three contact-making ammeters each provided with dashpots to prevent hunting, and with coils provided with taps which are used to vary the amount of power supplied to the furnace. Beneath are three small dial switches which are connected to the coil taps. On the lowest section there are four d.p.s.t. knife-blade switches with fuses, one switch being used for the line and the other for the electrode motors.

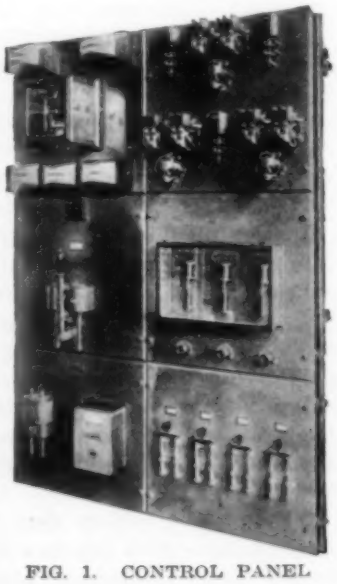


FIG. 1. CONTROL PANEL

Each contactor group consists of three units all mechanically interlocked, two contactors being normally open and one being normally closed.

Facing the panel, the left-hand contactor of any group makes the necessary connections to raise the electrode, while the right-hand contactor causes the electrode to be lowered and the bottom contactor short-circuits the motor armature through a resistance, in this way dynamically braking all moving parts and stopping them almost instantly. A higher resistance is connected in circuit with the armature when lowering than when raising, this being done to keep the speed approximately constant.

The shunt-wound electrode motor is connected to the line until the desired regulation is obtained, when the motor is disconnected and stopped almost instantaneously by means of dynamic braking, this method giving the simplest and most positive control of the electrode movement. The type of motor used was designed for this particular service, especially in regard to self-lubricating bearings, and ranges in size from 1 to 1½ hp. for small equipments, to 5 hp. for 15- to 20-ton furnaces.

The higher power used can be seen by taking for example, the 6-ton furnace, which is the size in greatest general use. The transformer capacity has increased from 900 kv-a. to 1500 kv-a., and even 1800 kv-a. has been proposed, all these capacities being based on 100 volts. In the variable voltage equipments the successful use of 150 volts renders it possible to increase the normal 1500 kv-a. up to 2250 kv-a.

Although 100 volts remains standard for refining, voltages up to 173 have been used for melting, these voltages being obtained either by high-voltage taps or high-voltage Y-data.

Fig. 2 shows a connection diagram of 3-phase furnace arranged for variable voltage operation by means of changing high-voltage connections. The high-melting voltage is obtained by connecting high-voltage windings delta, and the low-refining voltage by connecting them "Y."

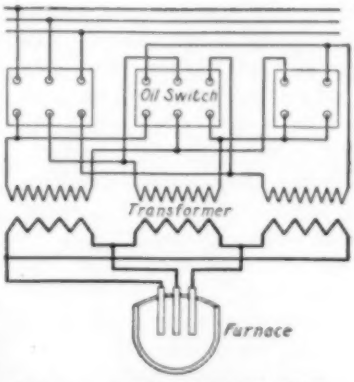


FIG. 2. THREE-PHASE FURNACE ARRANGED FOR VARIABLE VOLTAGE OPERATION

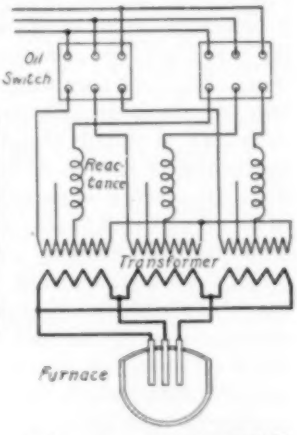


FIG. 3. CONNECTION DIAGRAM OF FURNACE EQUIPMENT USING REACTANCE

When it is considered desirable to use external reactance with high-voltage taps, the method shown in Fig. 3 is used. Variable voltage is obtained by means of high-voltage taps and external reactance is provided to be cut in during the melting period.

The use of high voltages during melting down, permits of decreasing the current for a given input, improves the power factor and insures higher emergency input when most needed.

Book Reviews

TREATISE ON APPLIED ANALYTICAL CHEMISTRY, by Professor *Vittorio Villavecchia*, Director of the Chemical Laboratories of the Italian Customs, translated by *Thomas H. Pope*, B. Sc., A. C. G. I., F. I. C., University of Birmingham. 1918, Vol. I. Price $6.00. 476 pages and 58 illustrations. Philadelphia: P. Blakiston's Son & Co.

One picks up this volume expecting to find a treatise on methods of separation as well as the customary opening chapters on weighing, filtering, igniting, etc.; but one is surprised to find that it is a compendium of analytical and other tests of economically occurring substances. The capitulation is by name of material or class. Chemical products are treated individually and in alphabetical order. Then follow chapters on classes of substances and materials such as fertilizers, cement materials, metals, fuels, coal-tar, oils and fats. Even stable manure has a place as a complex fertilizer. Asphalt appears to be overlooked; rubber, paints and glass likewise. There is much material of a non-analytical or non-chemical text throughout as a consequence of this method, resulting in chapters or paragraphs on such subjects as technical tests of cement and

photometric tests of illuminating oils. There are tests described for the thoroughness of metallic coatings, gilding, silver and nickel plating, oxidizing, etc. The translator's work is excellent, but at times his art is not concealed. Thus "newly won" in the following sentence, "When newly won, lignites contain 20-60% moisture" may be good rendering of a happy Italian phrase, but in English it is not colloquially technical or technically colloquial. As a whole the work is extremely valuable for its full compilation of specific tests and criteria, standards and requirements for commercial purity of industrial chemical substances.

* * *

ELECTRIC FURNACES IN THE IRON AND STEEL INDUSTRY. By *Rodenhauser* and *Schoenawa*. Translated from the German by *C. H. Vom Baur*. Second edition, octavo (14 x 22 cm.), xviii + 429 pages, 135 illustrations. Price $3.75. New York: John Wiley & Sons. London: Chapman & Hall, Ltd.

The first edition of this noteworthy book, appearing in 1913, made its mark, and was duly reviewed by us. This new edition has been largely re-written, and much new material added to keep pace with the developments of the last four years. We would like to have seen a fuller description given of the Heroult furnace, since it is the one in largest use, and more complete directions as to using burned dolomite instead of burned magnesite in making up furnace hearths, since the former is more sensitive to impurities than the latter, and account should be taken of that fact. Yet, there is no other book in English which covers this ground so thoroughly and satisfactorily; it is invaluable to the iron and steel metallurgist, and highly instructive to all using or interested in electric furnaces.

* * *

LUBRICATING ENGINEERS' HANDBOOK. By *John Rome Battle*. 334 pages. Illustrated. Price, $4.00. Philadelphia: J. B. Lippincott Company.

The author of this book has produced a very commendable work, both in the theory and practical application of lubricants, and the book should appeal to those interested in lubrication in general.

Considerable extraneous information is included in the book, which is more of a mechanical engineering than of a lubricating nature, and many pages have been covered with matter of a purely descriptive nature regarding various machines, their moving parts, and other apparatus used in the industrial arts. Such miscellaneous information as has been included can be found in most good books on mechanical engineering and it appears somewhat out of place in a book devoted to lubrication. Almost every kind of a machine and apparatus requiring lubrication has been described along with the principles of their lubrication. Very little literature pertaining to lubricating oils and their application has been written; consequently for those seeking general information on this subject the book should prove of interest. As a reference work, however, the book would not appear to be very useful, as the subject matter is too general in nature. The book is well written in language understandable by the layman, and the subject matter is arranged in logical sequence; the type is large and easily read, on good paper, and the illustrations are numerous.

* * *

HYDRO-ELECTRIC POWER STATIONS. By *Eric A. Lof* and *David Rushmore*. Price $6.00. New York: John Wiley & Sons, Inc.

A timely interest attaches to any book on this subject owing to the impending reawakening of hydro-electric development. The present treatise gives an outline of current practice in the various phases of engineering involved. The authors claim that "this book deals with and explains the problems which must be solved in connection with the construction and management of a hydro-electric power station, so that the manager or engineer may select power equipment and fully understand the economic factors which enter into each individual situation." Unfortunately the book does not do this in as large a measure as could be desired. The discussion of the fundamental problems involved is too meagre and too much wanting in critical quality to be much of a guide either to the student or the engineer. On the other hand the book furnishes a fairly complete picture of standard practice at the present time, particularly in regard to the electrical portion of the subject. It is in this phase that the authors of course are chiefly interested; and this probably accounts for the fact that about 300 pages of the book have been devoted to matters concerning electric generation, transformation, transmission, etc., that are in no way peculiar to hydro-electric power generation. The dearth of books on this subject impels us to admit, however, that we know of no more satisfactory treatise; and for a really satisfactory one we shall probably have to wait until the subject is tackled by some engineer whose experience on the anterior side of the turbine coupling is equivalent to that of the authors on the posterior side—and that may be a long while.

* * *

THE JOURNAL OF THE INSTITUTE OF METALS, Vol. XVIII. Edited by *G. Shaw Scott*, 21/-net. The Institute of Metals, 36, Victoria Street, London.

There is continued in the present volume the invaluable discussion on metal melting that was inaugurated by the institute last year. A new system of gas-firing is described which is claimed to enable metals to be melted exceedingly economically and which effects great savings in coal. The possibilities of using powdered coal for brass melting are fully discussed by numerous fuel experts.

Though brass is so important for war work and so much space is devoted to its consideration in the *Journal*—notably in the case of Dr. Parker Haigh's article "Experiments on the Fatigue of Brasses"—other of the non-ferrous metals and alloys that the Institute of Metals exists to study receive attention. Thus we find Professor H. C. H. Carpenter, who is to be this year's president of the institute, contributing a valuable paper, jointly with Lieut. L. Taverner, on the effects of heat on aluminium sheet. Other metallurgical problems discussed relate to high temperature thermostats, the effect of hydrostatic pressure on metals, and etching re-agents. A valuable treatise is given by Professor T. Turner, on "Hardness and Hardening," in which the latest views upon this subject are ably summarized and discussed.

Engineers will be specially interested in Professor W. E. Dalby's full and completely illustrated account of the researches that he has made with the aid of his remarkable "autographic load-extension optical indicator."

The volume under review concludes with a section in which concise abstracts are given of all recent literature bearing on metals.

* * *

EYE HAZARDS IN INDUSTRIAL OCCUPATIONS. By *Gordon L. Berry*, Field Secretary, National Committee for the Prevention of Blindness, with the co-operation of Lieut. Thomas P. Bradshaw, U. S. Army, formerly Technical Assistant to the Director of the American Museum of Safety. (Octavo, 150 pp., illus.) Published by the National Committee for the Prevention of Blindness, 130 East Twenty-second Street, New York. Price, 50 cents.

In this volume the author reviews the chief industrial hazards to eyesight in the industries of the United States. Case reports illustrate each section, the special dangers are described and recommendations made for such changes of working conditions, or installations of protective devices, as have been found suitable for protecting workers. The book is most completely illustrated.

The following section headings indicate the scope of the book: Statistics of Eye Accidents, Chipping Operations, Machine Operations, Abrasive Wheels, Sand-Blasting, "Mushroomed" Tools, Riveting, Radiations from Intense Light and Heat Sources, Ultra-violet Rays in Illuminants, Radiant Energy in Arc Welding and in Molten Metal, Metallurgical Operations, Glassblowers' Cataract, Infections, Gage Glasses, Acids and Chemicals, Treatment of Acid

Burns, Industrial Poisons, Removal of Dangerous Fumes, Vapors and Gases, Spray Process Hazards, Methyl Alcohol, Bottling Accidents, Mining and Quarrying, Agricultural Hazards, Goggles, Garment Trade Hazards, Industrial Lighting, the Safety Movement.

These subjects have been treated not so much in the way of a technical manual for safety engineers, but rather in a general informative way for the information of the average manufacturer or layman who is seeking information of this nature. Descriptions of many of these hazards have been included heretofore in publications covering the complete field of industrial accident prevention, and where discussion of preventive measures would be repetition the author has referred his reader to the chief of those sources where such detailed information might be secured, if desired.

Much of the "laboratory work" in the preparation of this book was accomplished in Buffalo, New York, where at the invitation of a large group of leading citizens a study was made of the eye hazards and methods in vogue for accident prevention in representative industries of that typical manufacturing city.

The book is the most complete compilation of material relating solely to the prevention of eye accidents that has been published in this country. Inasmuch as there occur annually in the United States alone nearly 200,000 eye accidents, from which many cases of total blindness result, it would seem that there is need for further attention to this important subject.

Personal

Mr. R. C. BERGEN, assistant editor of METALLURGICAL AND CHEMICAL ENGINEERING, has resigned to go into chemical manufacturing work. He has been connected with this journal since its change to a semi-monthly in 1915 and was formerly chemical engineer with the Roessler & Hasslacher Chemical Co., at Perth Amboy, N. J.

Mr. CHARLES PHILIP COLEMAN has been elected president of the Worthington Pump and Machinery Corporation. Mr. Coleman advances from the position of vice president, held since May, 1916, to the presidency. He was, prior to that date, receiver of the International Steam Pump Company and associate companies, which have now been reorganized into the present corporation, which owns and controls large works manufacturing pumping machinery and affiliated lines.

Mr. FRANCIS C. FRARY, research chemist of the Aluminum Company of America, has been commissioned as captain in the ordnance reserve corps and assigned to research work in the trench warfare section, Engineering Bureau, office of the Chief of Ordnance, Washington, D. C.

Mr. H. E. IVES, formerly with the United Gas Improvement Company, Philadelphia, Pa., has entered the science and research division of the United States signal corps and is now stationed in Washington.

Mr. HENRY H. MANDLE has resigned from his position as chief of the technical staff of Herman & Herman, Inc., and has reverted to his former practice as a consulting chemical engineer with offices at 220 West 42d St., New York. Mr. Mandle has also become interested in the National Bronze & Chemical Works, for whom he is acting in the capacity of technical adviser.

Mr. LOUIS S. MUNSON, associated with the Ault & Wiborg Company, Cincinnati, O., for the past eleven years in the capacity of chemist, has resigned to take charge of the production department of the new dye plant being erected by the du Pont's on the Delaware River near Wilmington.

Dr. J. C. OLSEN has accepted the position of Professor of Chemical Engineering and Head of that department at the Polytechnic Institute of Brooklyn. A new chemical engineering laboratory is to be equipped and installed at the Polytechnic Institute, and more emphasis given to the course in Chemical Engineering, both day and evening. Considerable more space is available for the work in Chemistry since the Institute has taken over the building used by the Preparatory Department. This building has been thoroughly overhauled and put in first-class condition. New chemical laboratories will be built in this building.

Mr. CHARLES M. SCHWAB, chairman of the Board of Directors of the Bethlehem Steel Corporation and president of the Bethlehem Shipbuilding Corporation, has been made Director General of the Emergency Fleet Corporation. He will devote all of his time to "speeding up" shipbuilding and has arranged to have the offices of the Fleet Corporation removed to Philadelphia, which is the center of shipbuilding in the East. He will have no connection with the letting of contracts.

Mr. E. GYBBON SPILSBURY has returned from Cuba, where for the last two months he has been studying the manganese situation.

Mr. A. E. WARD has been appointed sales manager of the International Oxygen Co., 115 Broadway, New York. Mr. Ward was formerly with the Prest-O-Lite Company and for many years has been associated with the compressed gas industries.

Current Market Reports

The Iron and Steel Market

The chief development of the past fortnight in the iron and steel situation has been a clear realization that the war requirements in steel are greater, in proportion to productive ability, than had been estimated. The steel makers find occasion to consider more seriously the matter of supplying adequately all the war activities, and particularly that of shipbuilding, than they had previously felt was necessary.

There have been some misunderstandings, which have been ironed out, and the steel makers are simply addressing themselves more strenuously to the task. It appears that the work of shipbuilding is accelerating more rapidly than was previously apparent. The vessel launchings of late, of which there have been precise statistics, are not a measure of the work that is proceeding. In other words, steel is being fabricated at the shops tributary to the shipyards at such a rate as to presage in due course a much heavier rate of vessel launchings, and vessel completion, than has obtained in the past few weeks.

The requirements in steel for our allies have visibly increased. It appears that some requirements were withheld from trade knowledge. In the past two or three weeks the trade has learned, for instance, that according to trustworthy reports General Pershing quietly borrowed from Britain and France steel in various forms representing a total of over 700,000 tons, and this steel General Pershing merely notified the Government it would have to find in the United States and ship abroad, to repay the loan. Of this particular amount 300,000 tons is to be in ship plates for British yards, while there are other and direct requirements in the same quarter.

From all that can be learned there is occasion to expect that iron and steel exports to our allies for the remainder of the year will be at a materially greater rate than has obtained in the past few months. This has a double influence upon the steel trade, for there is not only the increase in exports to be reckoned, but also the fact that exports in recent months have been made up rather largely of steel that had been accumulating for a long period on the Atlantic seaboard. Lately the shipments from mills, for export, have been much less than the tonnage actually leaving the country.

With these new developments it appears that a larger amount of steel will be required for prosecuting the war than was represented by the appraisals current at the beginning of April. With production unchanged from anticipations, the supply of steel remaining for purely commercial purposes, not connected with the war, will be less than had been expected.

The iron and steel market has given concrete testimony to the situation now confronting the trade. Since about

the first of March shipments of pig iron and of finished steel products to commercial consumers have been much greater than in the first two months of the year, probably at least twice as great. In some quarters it was thought that such an increase would soon result in commercial consumers being fully supplied. Their requirements are, of course, much less than before the country became as fully engaged in prosecuting war as it now is. On the other hand, it is quite certain that the requirements have increased over those of early in the year, when consumers were hampered in their operations, just as producers were.

There has been no material increase in production in April as compared with March. The output of pig iron has been larger, but there has hardly been a commensurate increase in the production of steel. Shortage of scrap is distinctly in evidence. The mills must now depend chiefly upon their own scrap and such as is obtained from industrial consumers engaged in war work. The usual flow of old material into consumption is quite generally arrested, as there is little new construction of a character that would displace old material, whether in industrial or municipal operations, or in the railroad field.

The restriction to blast furnace operations in the central west through insufficient car supplies in the Connellsville region has been fully as great in April as in March, when there was a noteworthy improvement over conditions in January and February. The furnaces dependent upon by-product coke now have practically full operation, and in occasional instances furnaces formerly dependent entirely upon Connellsville coke have been able to secure by-product coke, a surplus over the producer's own requirements. For a complete solution of the coke situation in the central west the completion of additional by-product ovens may perhaps have to be awaited. Ovens with a capacity of about 100,000 tons of coke a week are scheduled for completion within a few months.

On the whole, operations in the iron and steel industry have been at the rate of about 85 per cent of capacity in the past two months, with no great changes from week to week. The output is approximately equal to the average output in 1916, but the capacity, by reason of new construction, is much larger. The tonnage that represented full operation in 1916 now represents an average of about 85 per cent operation. In view of the great decrease that has occurred in the commercial, or peace, consumption of steel since 1916, it is obvious that an enormous tonnage is released, voluntarily or otherwise, for prosecuting the war.

The markets have been very quiet. Nearly all shipments are in connection with war operations, or against old commitments by ordinary consumers, whose deliveries have been greatly delayed. Throughout the market prices are at the prescribed maximum limits.

Non-Ferrous Metal Market

Monday, April 22.—There is nothing much to report in copper and tin. Lead and spelter continue weak. The price of nickel has been fixed by agreement. Antimony is unchanged.

Copper.—Consumers have been able to obtain sufficient supplies for their purposes and as the refinery production is increasing there is no sign of any copper shortage. The price remains as fixed by the Government at 23½c. per pound for producers and 24.67½c. per pound for jobbers.

Tin.—New business in tin is practically at a standstill as Chinese tin is held at a very high price and other brands are off the market. Australian tin for future delivery has appeared on the market at about 85½c. for June shipment. Arrivals at Atlantic ports up to April 17 were only 420 tons, mostly from the United Kingdom.

Lead.—The trust price was reduced to 7c. on Apr. 11, the actual market having been under that of the trust for some time. The market is quiet with principal producers asking 7c. New York and 6.92½c. E. St. Louis. Independents ask 7⅛ to 7¼c. New York.

Spelter.—The market continues dull with commercial spelter at 6.92½c. New York and 6.75-6.80 E. St. Louis for spot lots. May delivery at New York is quoted at 6.92½-7.02½, June at 5c. higher, and July at 5c. higher than June.

Nickel.—An agreement has been reached between the International Nickel Co., Bernard M. Baruch and the Council of National Defense, by which high-grade nickel will be sold at 40c. and the lowest grades at 38c.

Antimony.—Now quoted at 12¼ to 12½c. per pound. There are more sellers than buyers and futures are not interesting to the former, the spot market commanding most of the attention.

OTHER METALS

Aluminium, lb., 98-99 per cent, virgin, Gov't price	.32
Bismuth, lb.	2.50-2.75
Cadmium, lb.	1.40
Nickel, electrolytic, lb.	.40
Silver, oz.	.95⅝
Platinum, oz.	108.00
Palladium, oz.	150.00
Cobalt, lb.	3.25-3.50
Magnesium, lb.	2.00
Quicksilver, Cal.	123.00
Quicksilver, Mexican	118.00

Chemical Market

COAL TAR PRODUCTS: The situation underwent but little change during the interval. Some of the important crudes like benzol were in better demand, but supplies are so liberal that chemical prices are inclined downward rather than otherwise. The intermediates in general were in fair demand and prices are inclined to firm up somewhat due to restricted offerings.

Benzol: A slight improvement is reported in the buying demand, and some fairly good size contracts were closed over the year. The increase in demand, however, is not great enough to absorb the large quantities on the market and the position is very weak. It is said that sales were made at a reduction in price, where a large quantity was involved.

Phenol: There are more offerings of this material than for some time heretofore. The demand is only routine and prices are easier.

Toluol: The government has released some fairly large quantities of late to the manufacturers of dye intermediates, but there is not a great deal available. Producers are not in a position to offer except with permission by the government. Second hands are taking advantage of the situation and are exacting all sorts of prices for the small quantities on hand.

Naphthalene: Offerings are not liberal, but the demand is so light that the position is weak, though prices are quotably unchanged.

Aniline Oil: The demand has been active and second hands are pretty well cleaned out, although small scattered offerings tend to keep prices at present levels.

Aniline Salts: There has been an active export demand of late and prices have firmed up as a result. There is little or no material in second hands, so that producers are realizing their own prices.

Beta Naphthol: The technical material is in steady demand, but the production is heavy and prices are unchanged.

Para Toluidine: Although the stringency in the toluol situation has caused some producers to curtail, there is no change in price as the demand is not particularly heavy.

Sulphanilic Acid: The production is confined to a few quarters. The demand is not heavy and prices are therefore unchanged.

Phthalic Anhydride: Competition between some of the large factors has caused a drop in price; there is a fair demand.

Benzidine Base: There is a fairly active demand, but there is an ample production and prices are unchanged.

Benzaldehyde: There are only a few concerns producing this material at present; this fact coupled with the scarcity and high prices of toluol tends to drive prices upward.

Monochlorbenzol: Large quantities of this material have backed up on the market with practically no demand; a very favorable price can be done.

HEAVY CHEMICALS: Trading generally has been comparatively quiet and the volume of business has been rather disappointing. As a rule the tendency of values has been downward with the exception of special items which are extremely scarce and for which there is a very heavy demand.

Caustic Soda: The market during the past two weeks has been rather listless but has been featured by a strong market for future deliveries and a rather easier position for spot stocks. Producers have had the situation well in hand and from 5c. to 5½c. has been quoted for shipments from plant basis works freight. Spot cars have sold at from 4.50 up to 5c. Sales at the former figure have been principally due to the fact that there has been a lack of buying inquiry for these cars and the holders have in some instances been pressed for cash. A few producers have named prices for 1919 but these have been on such a high level that consumers have naturally shown but little tendency to cover. Buyers seem to feel that the new prices have been named merely to feel out the market.

Soda Ash: A lack of consuming demand and increased shipments have tended to ease off an easy situation. Barrels were for the most part rather firm but at the moment of writing have eased off and are obtainable at 2.85 spot New York. Bags have been very weak and have been quoted as low as 2.40 Philadelphia and 2.50 New York.

Bichromate of Soda: The market has not been subject to marked change during the interval but has been subject to fluctuation practically daily. Considerable speculation is still rife despite the fact that large losses have been the rule in the past in transactions of this sort. Sales of spot have occurred between 21c. and 22c. with the market occasionally up to 23c. As a rule small lots have sold at lower prices than car quantities.

Acetic Acid: This product has been one of the features of the chemical market. As has been the rule when the government assumed control of industry, prices have soared skyward with supplies almost impossible to be obtained. Producers have been disposing of production to certain approved buyers but for outside business the 20% material has sold as high as 15c. Some 56% material is held at 23c. Glacial has sold at 37c. and 38c., with sellers asking 40c. and even more.

Cyanide of Soda: While the regular trade has been asking 40c. and 42c. there have been resales from time to time at prices ranging from 38c. upward. On contract producer quotes 37c. for the soda and 32c. for the mixture for regular consumers only.

Copper Sulphate: A lack of consuming demand has resulted in practically no important business of late and resale lots have been on the market from time to time at prices ranging from 8.80 to 9.10. The regular trade has quoted from 9.25 to 9.50.

Sulphuric Acid: The production seems to have overcome the demand somewhat and acid has backed up on some manufacturers with the result that offers of sixty-six brimstone acid have been made at $35.00 sellers tanks works. The sixty degree brimstone acid has been available at $25.00 sellers tanks works. Resale lots of sixty-six acid have changed hands as low as at $32.50 New Jersey point.

Oleum: This situation has also been somewhat easier. Twenty per cent material has been rather difficult to move at $65.00 tanks and $70.00 drums, although there has not been a great deal of material offered on the open market. Sixty per cent oleum is being produced in a limited way and sales have occurred at $225 per ton.

Nitric Acid: Some acid not water white probably aqua fortis is being offered at 8¾c. works but for prime white material producers will not shade 9c. and there are makers who are holding to as high as 9.60 for the 42 degree material.

Muriatic Acid: The situation has been firm and twenty degree material is held firmly at 2¼c. as a minimum trading level at works. Offers of the 22 degree material are more restricted as the warm weather approaches and while some acid has been available at 2.50 works, generally 2¾c. and even 3c. has been obtained for moderate quantities. Carboys continue scarce and restrict the movement in all acids to a noticeable extent.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, APRIL 23, 1918

Acetic anhydride	lb.	1.35 —	1.50
Acetone, drums	lb.	Nominal	
Acid, acetic, 28 per cent	lb.	Nominal	
Acetic, 56 per cent	lb.	Nominal	
Acetic, glacial, 99½ per cent., carboys	lb.	.40 —	.41
Boric, crystals	lb.	.13½ —	.14½
Citric, crystals	lb.	.87 —	.88
Hydrochloric, C. P	lb.	Nominal	
Hydrochloric, 20 deg	lb.	.02½ —	.02½
Hydrochloric, conc., 22 deg	lb.	.02½ —	.03
Hydrofluoric, 30 per cent., in barrels	lb.	.06 —	.06½
Lactic, 44 per cent	lb.	.15½ —	.16
Lactic, 22 per cent	lb.	.06 —	.06½
Molybdic, 85 per cent	lb.	3.85 —	
Nitric, 36 deg	lb.	.08½ —	.08½
Nitric, 42 deg	lb.	.09 —	.10
Oxalic, crystals	lb.	.43 —	.45
Phosphoric, 47-50 per cent. paste	lb.	.08 —	.10
Phosphoric, ref. 50 per cent	lb.	.26 —	
Picric	lb.	Nominal	
Pyrogallic, resublimed	lb.	3.10 —	3.15
Sulphuric, 60 deg	ton	25.00 —	27.50
Sulphuric, 66 deg	ton	35.00 —	40.00
Sulphuric, oleum (Fuming), tank cars	ton	60.00 —	75.00
Tannic, U. S. P., bulk	lb.	1.30 —	1.35
Tartaric, crystals	lb.	.75 —	.78
Tungstic, per lb. of W	lb.	1.70 —	1.75
Alcohol, sugar cane, 188 proof	gal.	4.93 —	4.95
Alcohol, wood, 95 per cent	gal.	.90½ —	.91
Alcohol, denatured, 180 proof	gal.	.68 —	.69
Alum, ammonia lump	lb.	.04 —	.04½
Alum, chrome ammonium	lb.	.18 —	.19
Alum, chrome potassium	lb.	.20 —	.21
Alum, chrome sodium	lb.	.12½ —	.13
Alum, potash lump	lb.	.08½ —	.09
Aluminium sulphate, technical	lb.	.02½ —	.02¾
Aluminium sulphate, iron free	lb.	.03½ —	.03½
Ammonia aqua, 26 deg. carboys	lb.	.25 —	.26
Ammonia, anhydrous	lb.	Nominal	
Ammonium carbonate	lb.	Nominal	
Ammonium nitrate	lb.	(Fixed price)	.15
Ammonium, sulphate domestic	lb.	.07½ —	.08
Amyl acetate	gal.	5.00 —	5.25
Arsenic, white	lb.	.17 —	.18
Arsenic, red	lb.	.65 —	.70
Barium carbonate, 99 per cent	ton	80.00 —	90.00
Barium carbonate, 97-98 per cent	ton	65.00 —	67.00
Barium chloride	ton	65.00 —	85.00
Barium sulphate (Blanc Fixe, Dry)	lb.	.02½ —	.02½
Barium nitrate	lb.	.09½ —	.10
Barium peroxide, basis 70 per cent	lb.	.30 —	.32
Bleaching powder, 35 per cent. chlorine	lb.	.02 —	.02½
Borax, crystals, sacks	lb.	.07½ —	.08½
Brimstone, crude	ton	Nominal	
Bromine, technical	lb.	.75 —	
Calcium, acetate, crude	lb.	Nominal	
Calcium, carbide	lb.	.12½ —	.13
Calcium chloride, 70-75 per cent., fused, lump	ton	27.50 —	30.00
Calcium peroxide	lb.	1.60 —	1.70
Calcium phosphate	lb.	.34 —	.35
Calcium sulphate 98-99 per cent	lb.	.09 —	.09½
Carbon bisulphide	lb.	.08½ —	.10
Carbon tetrachloride, drums	lb.	.15½ —	.16
Carbonyl chloride (phosgene)	lb.	1.10 —	1.50
Caustic potash, 88-92 per cent	lb.	.83½ —	.84
Caustic soda, 76 per cent	lb.	.048 —	.05
Chlorine, liquid	lb.	.15 —	.18
Cobalt oxide	lb.	1.60 —	1.65
Copperas	lb.	.01¼ —	.01½
Copper carbonate	lb.	.30 —	.40
Copper cyanide	lb.	.75 —	.78
Copper sulphate, 99 per cent., large crystals	lb.	.09 —	.09½
Cream of tartar, crystals	lb.	.63 —	.65
Epsom salt, bags, U.S.P	lb.	.03½ —	.03½
Formaldehyde, 40 per cent	lb.	.19 —	.19½
Glauber's salt	100 lb.	1.50 —	2.00
Glycerine, bulk, C. P	lb.	.66 —	.67½
Iodine, resublimed	lb.	4.25 —	4.35
Iron oxide	lb.	.13 —	.15
Lead, acetate, white crystals	lb.	.17 —	.18
Lead, arsenate (Paste)	lb.	.15 —	.18
Lead nitrate	lb.	.15 —	.16
Litharge, American	lb.	.09½ —	.11½
Lithium carbonate	lb.	1.50 —	2.00
Manganese dioxide, U. S. P	lb.	.70 —	.75
Magnesium carbonate, technical	lb.	.10½ —	.11
Nickel salt, single	lb.	.14 —	.15
Nickel salt, double	lb.	.12 —	.14
Phosgene, see Carbonyl chloride			
Phosphorus, red	lb.	1.30 —	1.50
Phosphorus, yellow	lb.	1.50 —	1.60
Potassium bichromate	lb.	.44 —	.46
Potassium bromide granular	lb.	1.35 —	1.50
Potassium carbonate calcined, 85-90 per cent	lb.	.55 —	.60
Potassium chlorate, crystals	lb.	.36 —	.40
Potassium cyanide, 98-99 per cent	lb.	Nominal	
Potassium iodide	lb.	3.75 —	3.80
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	325.00 —	350.00
Potassium nitrate	lb.	.27 —	.31
Potassium permanganate (U. S. P.)	lb.	3.80 —	4.00
Potassium prussiate, red	lb.	2.80 —	2.90
Potassium prussiate, yellow	lb.	1.18 —	1.25
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	Nominal	
Rochelle salts	lb.	.41 —	.42
Salammoniac, gray gran	lb.	.17 —	.18
Salammoniac, white gran	lb.	.15½ —	.16
Sal soda	100 lb.	1.35 —	1.40
Salt cake	ton	24.00 —	27.00
Silver cyanide, based on market price of silver	oz.	—	
Silver nitrate	oz.	.61½ —	.62
Soda ash, 58 per cent., light, flat (bags)	100 lb.	2.50 —	2.60

Soda ash, 58 per cent., dense, flat	100 lb.	3.75	—	....
Sodium acetate	lb.	.23	—	.24
Sodium bicarbonate, domestic	lb.	.02½	—	.03
Sodium bicarbonate, English	lb.	....	—	....
Sodium bichromate	lb.	.22½	—	.23
Sodium bisulphite, powd	lb.	.05½	—	.06
Sodium chlorate	lb.	.24	—	.25
Sodium cyanide	lb.	.38	—	.40
Sodium fluoride, commercial	lb.	.18	—	.19
Sodium hyposulphite	lb.	.02½	—	.02½
Sodium molybdate, per lb. of Mo	lb.	2.50	—	....
Sodium nitrate, 95 per cent	100 lb.	Nominal		
Sodium nitrate	lb.	.33	—	.34
Sodium peroxide	lb.	.45	—	.50
Sodium phosphate	lb.	.04	—	.05
Sodium prussiate, yellow	lb.	.41½	—	.42
Sodium silicate, liquid (60 deg.)	lb.	Nominal		
Sodium sulphide, 30 per cent., crystals	lb.	.02½	—	.03
Sodium sulphide, 60 per cent., fused	lb.	.05½	—	.06
Sodium sulphite	lb.	Nominal		
Strontium nitrate	lb.	.25	—	.35
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.40
Sulphur, flowers, sublimed	100 lb.	4.05	—	4.60
Sulphur, roll	100 lb.	3.70	—	3.85
Sulphur, crude	ton	Nominal		
Tin bichloride, 50 deg	lb.	.23½	—	.24½
Tin oxide	lb.	.78	—	.80
Zinc carbonate	lb.	.25	—	.30
Zinc chloride	lb.	.12½	—	.13
Zinc cyanide	lb.	Nominal		
Zinc dust, 350 mesh	lb.	.14	—	.16
Zinc oxide, American process XX	lb.	.14	—	.15
Zinc sulphate	lb.	.05	—	.06

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.30	—	.35
Benzol, 90 per cent	gal.	....	—	....
Toluol, pure, water white	gal.	Nominal		
Xylol, pure, water white	gal.	.35	—	.50
Solvent naphtha, water white	gal.	.17	—	.22
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.33	—	.35
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.35	—	.38
Creosl, U. S. P	lb.	.18	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	—	1.25
Alpha naphthol, distilled	lb.	1.60	—	2.00
Alpha naphthylamine	lb.	.58	—	.60
Aniline oil, drums extra	lb.	.25½	—	.27
Aniline salts	lb.	.32	—	.34
Anthracene, 80 per cent	lb.	.50	—	.65
Benzaldehyde (f.f.c.)	lb.	5.25	—	5.50
Benzidine, base	lb.	1.75	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.50
Benzoic acid U. S. P	lb.	4.25	—	4.50
Benzoate of Soda, U. S. P	lb.	4.00	—	4.25
Benzyl chloride	lb.	2.25	—	2.50
Beta naphthol benzoate	lb.	10.00	—	12.00
Beta naphthol, sublimed	lb.	.85	—	.90
Beta naphthylamine, sublimed	lb.	2.65	—	....
Dichlor benzol	lb.	.12	—	.18
Diethylaniline	lb.	4.50	—	5.00
Dinitro benzol	lb.	.35	—	.40
Dinitrochlorbenzol	lb.	.40	—	.42
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.55	—	.60
Dinitrophenol	lb.	.46	—	.50
Dimethylaniline	lb.	.65	—	.70
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	2.25	—	2.50
Metaphenylenediamine	lb.	2.00	—	2.25
Monochlorbenzol	lb.	.17	—	.19
Naphthalene, flake	lb.	.10½	—	.10½
Naphthalene, balls	lb.	.12	—	.13
Naphthionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.	....	—	....
Ortho-dichlor-benzol	lb.	.15	—	.18
Ortho-toluidine	lb.	1.25	—	1.30
Ortho-nitro-toluol	lb.	.75	—	1.00
Para-amidophenol, base	lb.	3.50	—	3.75
Para-amido-phenol, H. Ch	lb.	4.00	—	5.00
Para-dichlor-benzol	lb.	.12	—	.15
Paranitraniline	lb.	1.25	—	1.30
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine (base)	lb.	3.00	—	3.25
Para toluidine	lb.	2.25	—	2.50
Phthalic acid anhydride	lb.	3.50	—	4.00
Phenol, U. S. P	lb.	.52	—	.54
Resorcin, technical	lb.	5.75	—	6.00
Resorcin, pure	lb.	8.50	—	9.00
Salicylic acid	lb.	.95	—	1.00
Salol	lb.	1.90	—	2.00
Sulphanilic acid, crude	lb.	.32	—	.35
Tolidin	lb.	2.25	—	2.50
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

(Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	....
Corning, Ohio	bbl.	2.85	—	....
Somerset, Ky	bbl.	2.50	—	....
Wooster, Ohio	bbl.	2.68	—	....
Indiana	bbl.	2.28	—	....
Illinois	bbl.	2.42	—	....
Oklahoma and Kansas	bbl.	2.25	—	....
Caddo, La., light	bbl.	2.25	—	....
Coriscana, Tex., light	bbl.	2.25	—	....
California	bbl.	.98	—	1.32
Gulf Coast	bbl.	1.35	—	....
Fuel Oil				
New York	gal.	.11	—	....
Pittsburgh	gal.	.07½	—	.10
Oklahoma-Kans	bbl.	1.05	—	2.75
Texas	bbl.	1.50	—	1.90
Los Angeles	bbl.	1.52	—	....
San Francisco	bbl.	1.45	—	....
Gasoline (Wholesale)				
New York	gal.	.24	—	....
Boston	gal.	.25	—	....
Pittsburgh	gal.	.27	—	....
Chicago	gal.	.21	—	....
Oklahoma	gal.	.25	—	....
San Francisco	gal.	.20	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.21	—	.22
Cylinder, light	gal.	.36	—	.38
Cylinder, dark	gal.	.35	—	.36
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, .903 sp. gr	gal.	.36	—	.38
Paraffine, .865 sp. gr	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	....
Pine oil, steam distillated, sp. gr. 0.925-0.940	gal.	.53	—	....
Pine oil, destructively distilled	gal.	.49	—	.53
Pine-tar oil, sp. gr., 1.025-1.035	gal.	.35	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.40	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f. o. b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tanks cars, f. o. b. works	gal.	.26	—	....
Pine tar, thin, spo. gr. 1.060-1.080	gal.	.30	—	....
Turpentine, crude, spo. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f. o. b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f. o. b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....
Wood creosote, ref. f. o. b. Florida	gal.	.31	—	....

Vegetable and Other Oils

China wood oil	lb.	.25½	—	....
Cottonseed oil, crude	lb.	.17½	—	.18
Linseed oil, raw, cars	gal.	1.54	—	1.55
Peanut oil, crude	gal.	1.37	—	....
Rosin oil, first run	gal.	.41	—	....
Rosin oil, fourth run	gal.	.58	—	....
Soya bean oil, Manchuria	lb.	.19	—	.19½
Turpentine, spirits	gal.	.41	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	Nominal		
Barytes, floated, white, domestic	ton	30.00	—	36.00
Beeswax, white, pure	lb.	.56	—	.64
Casein	lb.	.22	—	.30
Chalk, light, precipitated, English	lb.	....	—	....
China clay, imported, lump	ton	17.50	—	36.00
China clay, domestic, lump	ton	12.50	—	20.00
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f. o. b. mines	ton	33.00	—	35.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Graphite, flake	lb.	.16	—	.18
Ozokerite, crude, brown	lb.	.65	—	.75
Ozokerite, American, refined, white	lb.	.75	—	1.00
Red lead, dry, carloads	lb.	.10	—	.11½
Rosin, 280 lb	bbl.	6.15	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	15.00	—	22.00
White lead, dry	lb.	.09	—	.10

Refractories, Etc.

(F. O. B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	Nominal		
Clay brick, 1st quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	32.00	—	35.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9x4½x2½	net ton	135.00	—	140.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent., carloads, f. o. b. Niagara Falls, N. Y	ton	200.00	—	....
Ferrocerium	lb.	20.00	—	....
Ferrochromium, per lb. of Cr	lb.	.50	—	....
Ferromanganese, domestic, 70 per cent. basis	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	5.00	—	....
Ferrosilicon, 75 per cent., f. o. b., N. Y	ton	....	—	....
Ferrosilicon, 50 per cent., carloads, del., Pittsburgh	ton	180.00	—	190.00
Ferrosilicon, 50 per cent., contract	ton	100.00	—	175.00
Ferrotungsten, 75-85 per cent., f. o. b., Pittsburgh	lb.	2.25	—	2.35
Ferrouranium, f. o. b. works, per lb. of U	lb.	7.00	—	7.50
Ferrovanadium, f. o. b. works	lb.	4.00	—	5.00

Ores and Semi-finished Products

Antimony ore, per unit		1.60	—	1.75
Chrome ore, 45 per cent. minimum, f.o.b. Cal., per unit	ton	1.40	—	1.60
Chrome ore, 43 per cent. and over, New York, per unit	ton	1.50	—	....
Manganese ore, 48 per cent. and over, per unit	ton	1.20	—	....
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1.80	—	....
Tungsten, Scheelite, per unit of WO_3	ton	24.50	—	....
Tungsten, Wolframite, per unit of WO_3	ton	24.00	—	....
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	....
Pyrites, foreign	unit	.17	—	.17½
Pyrites, domestic	unit	.28	—	.30

INDUSTRIAL

Financial, Construction and Manufacturers' News

New Companies

The ALUMINUM ROLLING MILLS COMPANY, Cleveland, O. Capital, $1,000,000. To operate a local plant for the manufacture of steel, etc. Incorporators: F. H. Pelton and George B. Folk, Cleveland.

The ANNA LEE MINING COMPANY, Carthage, Mo. Capital, $75,000. To mine for lead and zinc. Incorporators: J. C. Wyatt, C. B. Pollard, R. A. Mooneyham, all of Carthage; C. Vernon, and W. C. Lucas, Kansas City.

The AUBUCHON SILICA MINING & MILLING COMPANY, St. Louis, Mo. Capital, $100,000. To mine for silica. Incorporators: Carl E. Aubuchon, Charles Spier, and Thomas B. Aubuchon.

The BOND CHEMICAL COMPANY, Camden, N. J. Capital, $125,000. To engage in the manufacture of chemicals and allied products. Incorporators: John J. Finney, Joseph Mallon, and F. M. Wick, Camden.

The CHICAGO COKE & CHEMICAL COMPANY, Portland, Me. Capital, $100,000. To operate a plant for the manufacture of chemicals, coke, iron, etc. Incorporators: P. B. Drew, C. G. Trott, and D. F. Drew, Portland.

The COLONIAL ANILINE WORKS, Monticello, N. Y. Capital, $10,000. To engage in the manufacture of dyestuffs and chemicals. Incorporators: P. S. Glickstein, W. and C. Lowenthal, 424 Caton Avenue, Brooklyn.

The CO-OPERATIVE FERTILIZER COMPANY, Miami, Fla. Capital, $30,000. To manufacture fertilizers. Incorporators: J. Petersen, C. M. Brown, Sr., and Charles D. Rowe.

The CORNWALL PAPER MANUFACTURING COMPANY, Cornwall, N. Y. Capital, $50,000. To manufacture paper and paper products. Incorporators: A. G. Lutz, F. B. Oldham, and L. Hecht, 403 Avenue C, Brooklyn, N. Y.

The DUNCAN LEAD & ZINC COMPANY, Duncan, Okla. Capital, $200,000. To engage in a general lead and zinc mining business. Incorporators: W. E. Williams, J. H. Goodnight, and W. M. Lockett, Duncan.

The EARLE CHEMICAL COMPANY, Wheeling, W. Va. Capital, $15,000. To engage in the manufacture of chemicals and kindred specialties. Incorporators: R. I. Runner, E. H. Draker, Eugene Hill, Raymond Sypher, and C. Rader, Wheeling.

The FOUNDRY EQUIPMENT & METALS COMPANY, Covington, Ky. Capital, $10,000. To operate a local foundry. Incorporators: L. A. and A. E. Clifton, and Frank X. Bertsch, Covington.

The HAMILTON ABRASIVE COMPANY, Westfield, Mass. Capital, $50,000. To manufacture abrasive materials of various kinds. Incorporators: F. D. Hamilton, Louis M. Fuller, and H. B. Putnam, Westfield.

The HARVEY CHEMICAL COMPANY, Hoboken, N. J. Capital, $50,000. To engage in the manufacture of chemicals and allied products. Incorporators: Jacob J. Harvey, East Orange; O. C. Harvey, Orange, and Harry B. Harvey, Newark.

The INTERSTATE LEAD & ZINC MINING COMPANY, Vinita, Okla. Capital, $40,000. To mine for lead and zinc. Incorporators: L. G. Sims, L. M. Linebaugh, Vinita, and S. P. Strong, Dallas, Tex.

J. F. LINBERG COMPANY, Inc., Jamestown, N. Y. Capital, $50,000. To manufacture chemicals and dyestuffs, etc. Incorporators: R. M. Bates, and E. J. and J. F. Linberg, all of Jamestown.

The LONE STAR LEAD & ZINC COMPANY, Miami, Okla. Capital, $200,000. To engage in a general lead and zinc mining business. Incorporators: B. C. Clark, Purcell; C. A. Clark, Oklahoma City; and R. I. Tibbs, Maypearl, Texas.

The LUDLUM STEEL COMPANY, Detroit, Mich. Nominal capital, $5,000. To manufacture steel and iron products. Incorporators: Lester P. Dodd, Norman J. Miller, and A. E. Perrin.

McCAFFREY & COMPANY, Inc., Philadelphia, Pa. Capital, $10,000. To engage in the manufacture of paper, paper boxes, etc. Joseph J. McCaffrey is the principal incorporator.

The MAXWELL PAINT COMPANY, Philadelphia, Pa. Capital, $10,000. To manufacture paints, etc. Morris Liveright is treasurer.

The MAYER & CLARKSON COMPANY, Buffalo, N. Y. Capital, $50,000. To manufacture iron and steel mill, shop, and foundry supplies. Incorporators: Alfred L. Mayer, A. A. Mayer, and C. B. Clarkson.

The MORRIS COUNTY CHEMICAL WORKS, Butler, N. J. Capital, $100,000. To operate a plant for the manufacture of chemicals, etc. Incorporators: John A. Marszalek, Thomas L. Sexsmith, William Joyce, and Walter A. Clark, Butler.

The NATIONAL BASIC FERTILIZER COMPANY, Birmingham, Ala. Capital, $137,000. To manufacture basic phosphate fertilizer. Incorporators: C. E. Elgin, Searles, Ala.; J. W. Lowman, Albany, and W. S. Oglesby, Searles, Ala.

The NEW LONDON CHEMICAL COMPANY, New London, Conn. Capital, $50,000. To manufacture chemicals and allied products. Incorporators: Bert W. Flanders, Ira M. Comstock, and H. E. Harris, New London.

The PANTO LEAD & ZINC COMPANY, Ada, Okla. Capital, $100,000. To mine for lead and zinc, etc. Incorporators: J. G. Witherspoon, Harmon Ebey, and Frank Jackson, Ada.

The PHILADELPHIA ELECTRIC STEEL CORPORATION, Wilmington, Del. Capital, $70,000. To manufacture electric steel and allied products. Incorporators: F. A. Armstrong, M. M. Clancy, and C. L. Rimlinger, Wilmington.

The PREMIUM ZINC MINING COMPANY, Oklahoma City, Okla Capital, $75,000. To engage in the development of zinc properties. R. L. Ritchie is the principal incorporator.

The CHARLES H. PRIME COMPANY, Inc., New York. Capital, $50,000. To manufacture strawboard, boxboard, cardboard, etc. Incorporators: P. H. Smeallie, C. H. Prime, and J. K. Voorhees, 200 Fifth Avenue.

The PYROTOL CHEMICAL COMPANY, Beaumont, Tex. Capital $35,000. To manufacture chemicals and allied products. Incorporators: Bruce Richardson, S. Gordon, E. J. Goodier, and A. H. Safir.

The RED RIVER VALLEY LEAD & ZINC COMPANY, Durant, Okla. Capital, $50,000. To engage in the development of lead and zinc lands. Incorporators: George B. Morris, G. Thompson, Durant, and J. H. Holland, Achille.

The ROBAX CHEMICAL COMPANY, Dover, Del. Capital, $100,000. To manufacture chemicals and kindred specialties. Incorporators: Cornelius A. Cole, Hackensack, N. J.; Arthur R. Oakley, Pearl River, N. Y.; and Paul E. Britsch, Brooklyn, N. Y.

JACOB RUBIN & SON, New York. Capital, $75,000. To manufacture plate and window glass. Incorporators: J., H. H., and L. Rubin, 1516 Fifty-fourth Street, Brooklyn.

The RUBY JACK MINING COMPANY, Harrison, Ark. Capital, $200,000. To mine for lead and zinc. Incorporators: C. C. Wolf, O. L. Perry, D. M. Ormand, Harrison.

The SEABOARD BRASS FOUNDRIES, Inc., Brooklyn, N. Y. Capital, $52,500. To operate brass and other foundries. Incorporators: Donald Hayes, 5 Hanson Place, and C. Holter, 173 Lenox Road, Brooklyn.

The UNITED STATES PAPER MILLS, Inc., Chambersburg, Pa. Capital, $30,000. To operate mills for the manufacture of paper. Milton Long is the principal incorporator.

The VOLCO LEAD & ZINC COMPANY, Oklahoma City, Okla. Capital, $200,000. To engage in the development of lead and zinc properties. Incorporators: O. R. Jeter, Brinkman; N. U. Stout, Snyder, and S. M. Jones, Headrick, Okla.

The WESTERN CHEMICAL PRODUCTS COMPANY, Vernon, Cal. Capital, $25,000. To manufacture chemicals and allied products. Incorporators: G. W. Marchand, Long Beach; W. T. Moore, Long Beach, and T. C. Yeager, Canton, Mo.

Construction and Operation

Alabama

BIRMINGHAM.—Announcement has been made by the Tennessee Coal, Iron & Railroad Company that extensive improvements and additions will be made at its Fairfield byproduct coking plant which will double the present capacity. The work includes the construction of two additional batteries of seventy-seven ovens each, or a total of 154 ovens, together with complete byproduct recovery plants. The ovens will be of the Koppers type. It is said that the project will involve an expenditure of about $2,000,000. George G. Crawford is president.

LOCK TWELVE.—In addition to the expenditure of $30,000,000 planned by the Government for the construction of a nitrate plant at Muscle Shoals, it is understood that an expenditure of $500,000,000 is planned for the erection of additional nitrate plants, one of these to be located near Lock Twelve on Warrior River.

Arizona

TUCSON.—Alfred Roos, of Tucson, and associates, are planning for the immediate construction of a large new plant for the handling of wulfenite concentrates.

MIAMI.—The Miami Copper Company is considering plans for the construction of a new addition to its plant to increase the present capacity. A 6,000-ton mill is now in operation.

California

BISHOP.—The Round Valley Tungsten Company is planning for extensive development work at the camp at the Pine Creek tungsten claims recently acquired, including the installation of two new Marcy mills having a combined capacity of 150 tons daily.

BOLINAS.—The Chetco Mining Company has commenced extensive development at its copper properties in Marin County near Bolinas, and operations have been inaugurated in a new 40-ton mill, comprising crusher, Hendy ball-mill, and Overstrom concentrator.

CRESCENT MILLS.—The Juneday Mining & Milling Company has completed the installation of new machinery at its properties in Plumas County, and is planning for the construction of a new 50-ton mill.

PITTSBURG.—The Columbia Steel Company is making rapid progress in the construction of a new addition to its plant to increase the present capacity by about fifty per cent. Immediately upon completion of the structure, the company will commence the installation of two 30-ton and one 10-ton traveling cranes and a new 15-ton locomotive crane. Power for operation will be supplied by the Pacific Gas & Electric Company.

SAN FERNANDO.—Plans have been filed by the San Fernando Canning Company for the construction of a new canning works, about 100 x 475 feet. The structure, contract for which has been awarded, is estimated to cost $25,000, and the equipment to be installed will cost $40,000.

Colorado

CRIPPLE CREEK.—The Camp Bird Mining, Leasing & Power Company has had plans prepared for the construction of a large new ore-house at its properties.

NEDERLAND.—The La Plaisance Mining & Milling Company, recently incorporated, is planning for extensive development work at the La Plaisance gold and silver mine, to be operated in connection with the New England mine. E. V. Grant, F. A. Fair, and Alfred Dawson are interested in the company.

PUEBLO.—Negotiations have been completed by the Norcross Chemical Company for the leasing of the plant formerly occupied by the Table Queen Baking Company on South Union Avenue, and the company is planning to commence work on alterations and improvements to utilize the plant as a chemical manufacturing works and laboratory. New machinery will be installed immediately upon completion of these improvements, the new plant to be devoted to the manufacture of bismuth compounds, copper oxide, and iodoform. The company has completed the construction of a large new manufacturing plant near Stone City, which will manufacture various acids and explosives. W. E. Young is vice-president.

SILVERTON.—The D., L. & W. Mining and Reduction Company is engaged in extensive development work at its properties, and plans are under consideration for the construction of a new mill along the Animas River. H. M. Kingsley is manager.

Connectnicut

BRISTOL.—The plant of the Munroe & Muzzy Pen Company, located in the Edgewood district, near Bristol, was recently partially destroyed by fire, with loss estimated at $50,000.

STAMFORD.—Baer Brothers, Canal Street, manufacturers of paints, etc., have commenced the reconstruction of the portion of its plant recently destroyed by fire, with loss estimated at $100,000. The company is planning to increase the former capacity of the plant.

Idaho

MULLAN.—The Copper King Mining Company is considering plans for the construction of a new 200-ton mill at its plant. H. W. Ingalls is manager.

SAGLE.—The Armstead Mines Company, which operates on Pend Creille Lake, has made an appropriation of $200,000 to provide for the erection of a new 100-ton mill and other development work. Plans have been prepared by O. H. Hofstrand, Salt Lake City, Utah. H. H. Armstead is president.

Illinois

CHICAGO.—The Interstate Iron & Steel Company, Seventy-eighth Street and South Chicago Avenue, has had plans prepared for the construction of a new one-story addition to its plant.

EAST ST. LOUIS.—The Lubrite Refining Company, Tulsa, Okla., has had plans prepared for the construction of a large new local plant on property recently acquired near Twentieth Street and the Alton & Southern Railroad, comprising about twenty-five acres. The plant, which will be devoted to the production of airplane lubricants, will have an initial capacity of 1,000 barrels daily, ultimately to be increased to 5,000 barrels. W. S. Strickler is president.

LA SALLE.—The Valley Chemical Company is rushing to completion the construction of a large new addition to its plant. Immediately upon completion of the structure, which it is estimated will be within the next three months, the company will install the necessary furnaces and machinery for operation.

Indiana

EVANSVILLE.—Plans have been completed by the Hercules Gas Engine Company for the construction of a large new addition to its plant, the structure to be one-story, about 175 x 450 ton. It is estimated that the new building will cost about $150,000.

TERRE HAUTE.—Plans are under consideration by the Rott Glass Company for the construction of a new addition to its plant.

Iowa

BELMONT.—The Valley Sugar Company, recently organized, has acquired the Elder property comprising about 270 acres and is planning for the construction of a large new plant for the production of beet sugar.

CEDAR RAPIDS.—Plans are under consideration by the Viking Pump Company, manufacturer of pumping machinery and equipment for the construction of a new addition to its plant, about 35 x 125 feet. The structure is estimated to cost $20,000.

Kansas

WICHITA.—The Lucky Eight Oil & Gas Company is planning for the construction of a large new oil refinery on a site now under consideration at Eldorado to have an initial capacity of 2,000 barrels daily. It is expected that the new plant will be ready for operation by August 1. F. L. Wright is president.

Kentucky

LOUISVILLE.—The Louisville Fertilizer Company, operating a mixing plant for the production of commercial fertilizer, is said to be considering the construction of a large plant on property adjoining its present works, the new factory to be devoted to the manufacture of nitrates.

Louisiana

LAKE CHARLES.—The United States Government has awarded a contract for the construction of a large new local oil refinery and research building to the American Construction Company, Houston, Tex, and work will commence at once.

Maryland

CUMBERLAND.—F. Brooke Whiting and I. Blaine White are arranging for the organization of a new company to operate the plant formerly occupied by the Eastern Glass Works, at South Cumberland. The works comprise five acres and extensive alterations and improvements will be made. The plant will be devoted to the manufacture of high grade glassware and it is expected to be completed within three months, giving employment to about 100 hands for initial operations.

Michigan

ALMA.—The R. & P. Tractor Company, recently incorporated, is planning for the immediate establishment of a local plant. F. W. Ruggles is president.

IRON MOUNTAIN.—The Aragon Mining Company is planning for the immediate operation of the Oliver properties, Norway, near Iron Mountain. New mining machinery will be installed immediately, the entire plant to be electrically operated.

WAYNE.—The Harroun Motors Corporation is considering plans for the construction of a new one-story addition to its plant. It is said that the structure, which is estimated to cost $150,000, will be used for the manufacture of shells for the Government.

Mississippi

CHARLESTON.—The Lamb-Fish Lumber Company has recently awarded a contract to the Unit Construction, St. Louis, Mo., for the construction of a large plant for the extraction of denatured alcohol and acetone from mill waste. It is said the works will cost about $1,000,000.

Missouri

ST. LOUIS.—Plans are under consideration by the Johnston Tin Foil & Metal Company, South Broadway, for the construction of a new two-story plant, about 80 x 100 feet. The works are estimated to cost about $50,000.

ST. LOUIS.—The St. Louis Coke & Chemical Company is having plans prepared for the construction of its proposed new plant at Granite City, Ill., estimated to cost $5,000,000. Included in the plans is the erection of a byproduct coke oven and two blast furnaces. This company is a subsidiary of the American Coke & Chemical Company.

Montana

EAST HELENA.—The Economy Mining Company is making rapid progress in the construction of a new 75-ton concentrating mill at the Economy mine, and extensive additional development work is contemplated.

Nevada

ELKO.—The Standard Oil Shale Company, which was reorganized at Salt Lake City, Utah, with a capital of $1,250,000, is planning for the construction of a new 100-ton plant for the distillation of oil from shale at its Elko properties. The company has acquired 4000 acres of land near Elko, and 1000 acres near Levan, Juab County, Utah.

New Mexico

HANOVER.—The Republic Mining & Milling Company has plans under consideration for the construction of a new 100-ton concentration mill.

New Jersey

JERSEY CITY.—The Hudson County Smelting & Refining Works has filed authorization papers to operate a smelting and refining plant at 489 Henderson Street. Jacob Laffer, 161 Pavonia Avenue, Jersey City, heads the company.

KEARNY.—Swift & Company have filed plans for the construction of a new five-story reinforced-concrete rendering plant to be located in the Kearny meadow district. It is said that this will be the largest plant of its kind in the East, the company planning to have a capacity of about 3,000,000 pounds of raw product monthly.

NEWARK.—The Butterworth-Judson Corporation, Avenue R, manufacturer of chemicals, is having plans prepared for the reconstruction of the portion of its plant recently destroyed by fire, with loss estimated at $200,000.

NEWARK.—The International Oxygen Company has taken out a building permit for the construction of a new plant at 796 Frelinghuysen avenue, estimated to cost about $20,000.

ELIZABETH.—The Linden Tanning Company has completed negotiations for the purchase of the tanneries of M. Straus & Sons, located at 442-68 Frelinghuysen Avenue, Newark, consisting of a series of two, three and four-story brick buildings containing approximately 250,000 square feet of floor space. The property was held at $400,000.

PERTH AMBOY.—The American Smelting & Refining Company has had plans prepared for the construction of a new addition to its plant to cost about $75,000.

PERTH AMBOY.—The Roessler & Hasslacher Chemical Company has taken out building permits for the construction of two new additions to its plant. Contracts for the structures have been awarded.

JAMESBURG.—The Texas Refining Company has recently acquired property near Jamesburg as a site for the construction of a new plant for the manufacture of lubricants. Construction work has been commenced on one of the units of the plant, a structure 50 x 50 feet. It is said that the company has received a contract from the Government for 10,000 barrels of grease for auto trucks.

BAYONNE.—The Standard Oil Company of Avenue K, having a frontage of 621 feet on the Kill von Kull, and extending about 840 feet to the National Docks Railroad, for a consideration said to be in the neighborhood of $775,000. It is said the property will be used for extensions.

New York

NEW YORK.—The American Aniline Products Company, 80 Fifth Avenue, has acquired the plant of the United Piece Dye Works, Nyack, N. Y., occupying the entire block fronting on Railroad Avenue, Cedar Hill Avenue, Hudson and Florence Streets. The works comprise a number of brick buildings, having a total floor space of about 93,045 square feet, and the property was held at $105,000. The company is planning to use the plant for the manufacture of aniline colors, principally khaki and navy blue, having secured a large contract from the Government.

BROOKLYN.—The Long Island Soap Company has had plans prepared for the construction of a new three-story reinforced-concrete plant, about 50 x 80 feet, at Bridgewater Street and Meeker Avenue. David M. Ach, 1 Madison Avenue, New York, is architect.

FULTON.—The Oswego Pulp & Paper Company, Fulton, has had plans prepared for the construction of a new three-story local plant, to cost about $60,000. Charles Eaton, Watertown, is architect.

Ohio

CLEVELAND.—The Standard Foundry Manufacturing Company has taken out a brick and reinforced-concrete addition to its plant at 2717 East Seventy-fifth Street.

CLEVELAND.—Fire, on April 10, following an explosion, damaged the plant of the Grabler Manufacturing Company to the extent of approximately $200,000. The company was engaged in the manufacture of hand grenades for the Government.

COLUMBUS.—The Columbus Metal Company, recently incorporated with a capital of $30,000, has inaugurated operations in its new foundry at 459 South Parsons Avenue. The company will engage in the manufacture of castings of all kinds.

HAMILTON.—The Bentel & Margedant Company has taken out a building permit for the construction of a new reinforced-concrete foundry building on Mill Road, to cost about $20,000.

YOUNGSTOWN.—The Carnegie Steel Company is said to be considering plans for the construction of extensive additions to its local plant, including the erection of a large new byproduct coke plant.

YOUNGSTOWN.—The Liberty Steel Company has plans under consideration for the construction of additions to its local plant to provide for increased capacity. It is said that the company will issue $600,000 of its stock, of which $350,000 will be common and $250,000 preferred, to provide working capital for this purpose. At the present time the plant has a capacity of 600,000 boxes of tinplate per year, and it is proposed to increase this to 900,000 boxes annually.

Oklahoma

POTEAU.—Edgar A. Berry and associates, operating a plant at Okmulgee for the manufacture of window glass, have completed negotiations with the local Chamber of Commerce for the removal of its plant to Poteau. It is estimated that the new works will cost about $50,000 and will give employment to about 125 hands for initial operations.

Pennsylvania

PHILADELPHIA. — Fels & Company, Seventy-third and Woodland Avenue, manufacturers of soaps, have had plans prepared for the construction of a new one-story brick addition to their plant, about 55 x 95 feet, at Woodland Avenue and island Road. Harris & Richards, Drexel Building, Philadelphia, are the architects.

MARCUS HOOK.—The General Chemical Company, 25 Broad Street, New York, has recently awarded a contract for the construction of a new one-story and basement service building, about 100 x 100 feet, at Marcus Hook. The structure is estimated to cost $100,000. The Carleton Company, 151 West Forty-second Street, New York, is the contractor.

NEW CASTLE.—The Grasselli Powder Company, Cleveland, O., has commenced the construction of its new local acid manufacturing plant, which will comprise eight one-story units and a power plant for works operation. It is said that the plant, when completed, will represent an investment of about $1,000,000.

PITTSBURGH.—The Yankee Steel Company of America, recently incorporated under Delaware laws with a capital of $1,000,000, is considering the construction of a large plant near Sharpsville for the manufacture of sheet steel products. Ephraim Truxall is president and general manager.

Rhode Island

PROVIDENCE.—The Standard Oil Company of New York has acquired a large tract of land near its local distributing station, and is said to be planning for the construction of a large new refinery, can factory, and shipbuilding works.

Texas

HOUSTON.—The Prairie Oil & Gas Company has recently acquired property on the Houston Ship Channel, comprising about 400 acres, as a site for the construction of a large new oil refinery. It is said that plans are under consideration for the construction of a pipe line from Cushing, through Ranger, to the ship channel.

QUANAH.—T. Sanford Gibbs is having plans prepared for the construction of a new concentration mill at his copper properties near Quanah.

Utah

GOLD HILL.—The Deep Creek Investment Company is considering the construction of a new local mill for the treatment of low-grade ore. F. W. Ferriss is president.

MARYSVALE.—Rapid progress is being made by the Florence Mining Company in the construction of a new 100-ton mill at its alunite properties. Jacob Young is manager.

Washington

CHEWELAH.—The Northwest Magnesite Company is planning for the installation of new machinery at its plant to provide for increased capacity. The improvement is estimated to cost $150,000.

KELLER.—The Iron Creek Mining Company is planning for the early construction of a new 25-ton mill at its properties.

West Virginia

MORGANTOWN.—The Economy Tumbler Company is planning for the construction of new additions at its glassware manufacturing plant to cost about $175,000.

PARKERSBURG.—The Brown Flint Glass Company, recently incorporated with a capital of $50,000, has completed its organization and is planning for the manufacture of glassware. J. W. Brown, of Vienna, is president.

Wisconsin

CUBA CITY.—The Hercules Mining Company of Wisconsin, recently incorporated with a capital of $100,000, is planning for the construction of a new 100-ton mill at its local properties located near Plattesville. Harry Seemiller is general manager.

Canada

TORONTO, ONTARIO.—Fire recently destroyed a portion of the plant of the Thor Iron Works, foot of Bathurst Street, with total loss estimated at $300,000.

Mexico

CANANEA.—The Calumet-Sonora Mining Company, whose properties are located about four miles from Cananea, has completed the construction of a new 500-ton concentrating plant for the treatment of ore from the Catalina mine.

Trade Notes

The ZAREMBA COMPANY, of Buffalo, has moved its offices to the Niagara Life Insurance Building, corner of Franklin and Mohawk Streets.

The YARNALL-WARING COMPANY, of Philadelphia, has decided to group its several power-plant accessory products under the family name of "Yarway."

The HUFF ELECTROSTATIC SEPARATOR COMPANY, owners and manufacturers of the electrostatic process of ore concentration, have opened an office at 120 Broadway, New York, for consultation regarding ore dressing problems, especially the dry concentration of ores and the separation of valuable minerals from others which are commercially detrimental. The office will be in charge of A. L. Sweetser.

The EASTON CAR & CONSTRUCTION COMPANY, Easton, Pa., announce the opening of a new Branch Office in Washington, D. C., the address being 225 Kellogg Building, 1422 F. Street, N. W.

SWEDISH BEATER FILLING NOW MANUFACTURED IN THE UNITED STATES.—Helin's beater filling, which has met with much success in Europe and particularly in Sweden, is now being manufactured and marketed in the United States by the Fibre Making Processes, Inc. 440 So. Dearborn Street, Chicago, Ill. This filling is a cast iron composition, combining a structure of basalt lava with strength and durability. The manufacturers claim that compared with steel knives this filling doubles the capacity with about the same power consumption.

NATIONAL ANILINE DIRECTORS.—At the annual meeting of the shareholders of the National Aniline and Chemical Co., Inc., held at 244 Madison Avenue, New York City, on February 18th, 1918, the following board of directors was elected:

Dr. Wm. Beckers, New York City.
H. H. S. Handy, Syracuse.
Dr. L. C. Jones, Syracuse.
Clinton S. Lutkins, New York City.
Wm. J. Matheson, New York City.
Eugene Meyer, Jr., New York City.
W. N. McIlravy, New York City.
T. M. Rianhard, New York City.
J. F. Schoellkopf, Buffalo.
C. P. Hugo Schoellkopf, Buffalo.
J. F. Schoellkopf, President, Buffalo.
Robert Alfred Shaw, New York City.
I. Frank Stone, New York City.
Dr. R. C. Taggersell, Buffalo.
Orlando F. Weber, New York City.
Henry Wigglesworth, New York.

The new names appearing in the above are Dr. Taggersell, chief chemist of the manufacturing department at Buffalo; Dr. Jones, chief chemist of the Semet-Solvay Company; Mr. C. S. Lutkins, Secretary of the General Chemical Company; Mr. Orlando F. Weber, now associated with the War Industries Board at Washington.

The house of PHILLIPPE BERGER, Paris, France, announces that it will send one of its engineers to the United States to be here during April and May. He will have full buying authority for machinery and raw materials and will consider propositions for the establishing of industries in France. Communications should be sent to M. León Belge, Hotel Biltmore, New York.

MARDEN, ORTH & HASTINGS CORPORATION, 61 Broadway, New York, has acquired the control of the Buttercup Oil & Car Company, of Louisville, Kentucky. Buttercup Oil & Car Company is reported to be one of the largest producers of edible oils in the United States, and it is understood that they will continue the refining of peanut, cocoanut and cotton seed oils, and other edible oils will be added to their production list.

SCHUTTE & KOERTING CO., TRANSFERRED.—At a meeting held on February 23, 1918. The stock of the company was transferred to the alien property custodian of the United States and at his instance the Board of Directors was reconstructed as follows: E. Pusey Passmore, Governor of the Federal Reserve Bank, Philadelphia; Ralph J. Baker, Asst. Gen'l Counsel of the alien property custodian; D. W. Hildredth, treasurer of Schutte & Koerting Co.; T. H. Johnston, Schutte & Koerting Co.; Chas. S. Calwell, president Corn Exchange National Bank, Philadelphia. The new board elected the following officers: Chas. S. Calwell, president; D. W. Hildreth, treasurer; Ralph J. Baker, secretary.

This ensures the active continuation of the business in all its lines.

THE SURFACE COMBUSTION CO. has changed its address from Long Island City to 366-368 Gerard Ave, Bronx, N. Y., where increased space and new equipment has been provided.

The PERMUTIT CO., manufacturers of water softening and water rectification apparatus, and for several years past located at 30 E. 42nd Street, New York, announces its removal on March 15th to 440 Fourth Ave., New York.

MONSANTO AND COMMERCIAL ACID CO. CONSOLIDATE. — The Monsanto Chemical Company of St. Louis has purchased the Commercial Acid Company of East St. Louis for a consideration in excess of $2,000,000. Announcement to this effect was made recently by John F. Queeny, president of the Monsanto Company.

The Commercial Acid Company's plant is on a tract of 140 acres, and is one of East St. Louis' largest industrial institutions. The Monsanto Company is one of the leading manufacturers of medicinal chemicals in this country. Its plant occupies two blocks in South St. Louis. The new corporation will be capitalized at about $5,000,000.

DYE PATENT LICENSES FOR DU PONT.—Recent applications to the Federal Trade Commission for licenses to manufacture under German-controlled patents under the "trading-with-the-enemy" act include several from E. I. du Pont de Nemours & Co. as follows: Applications covering patent No. 868,294, on a process of producing phenylglycin and its homologues, held by the Farbwerke Hoechst and patent No. 680,395, on a process of making indoxyl derivatives, held by the Roessler interests, of Frankfort-am-Main. No. 818,992, anthracene dye and process of making, patent of Bally & Isler; No. 787,859, anthracene compound and process of making, patent of Scholl & Bally; No. 1,003,268, anthracene dye and process of making, patent of Just & Wolf; No. 796,393, anthracene coloring matter and process of producing, patent of Bally; No. 753,659, anthracene derivative and process of making, patent of Rene Bohn; No. 739,145, anthracene dye, patent of Bohn; No. 1,055,701, pigment and process of making, patent of Bohn; No. 724,789, blue dye and process of making, patent of Bohn; No. 1,063,173, producing aminoanthraquinone and derivatives, patent of Rampini; No. 906,367, anthracene dye and process of making, patent of Bally & Wolff; No. 711,377, solid alkaline hydrosulphites and process of making, patent of Bazlen; No. 961,612, anthracene compound and process of making, patent of Isler & Wolff; No. 931,958, sulphur dye and process of making, patent of Haas; No. 795,755, process of making stable dry hydrosulphites, patent of Bazlen.

All of the last fourteen patents enumerated above were held on assignment by the Badische Anilin und Soda Fabrik, of Ludwigshafen am Rhein.

NEW CHEMICAL COMPANIES organized during January had capital of eleven million dollars compored with seven million dollars for such organizations in December and less than four million dollars for those formed in January a year ago. Capital invested in chemical companies for manufacture of chemicals, drugs and dyes in this country since the war began now stands at three hundred and thirty-nine million dollars.

Manufacturers' Catalogs

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., has issued catalog 8-E, describing Westinghouse industrial heating apparatus.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has issued two small circulars, one on the "C-H electric space heater unit" and the other on the "C-H electric air heaters." An 8-page booklet has also been issued describing the Thomas meter for measuring gases and air in large quantities.

CENTRAL SCIENTIFIC COMPANY, Chicago, Ill., has issued circulars describing De Khotinsky constant temperature heating appliances and Cenco direct current meters.

SARCO COMPANY, INC., New York, has issued a folder describing Sarco metallic gasket.

ELECTRIC MACHINERY COMPANY, Minneapolis, Minn., has issued Bulletin 176 describing vertical type alternators directly connected to waterwheels.